United States
Environmental Protection
Agency

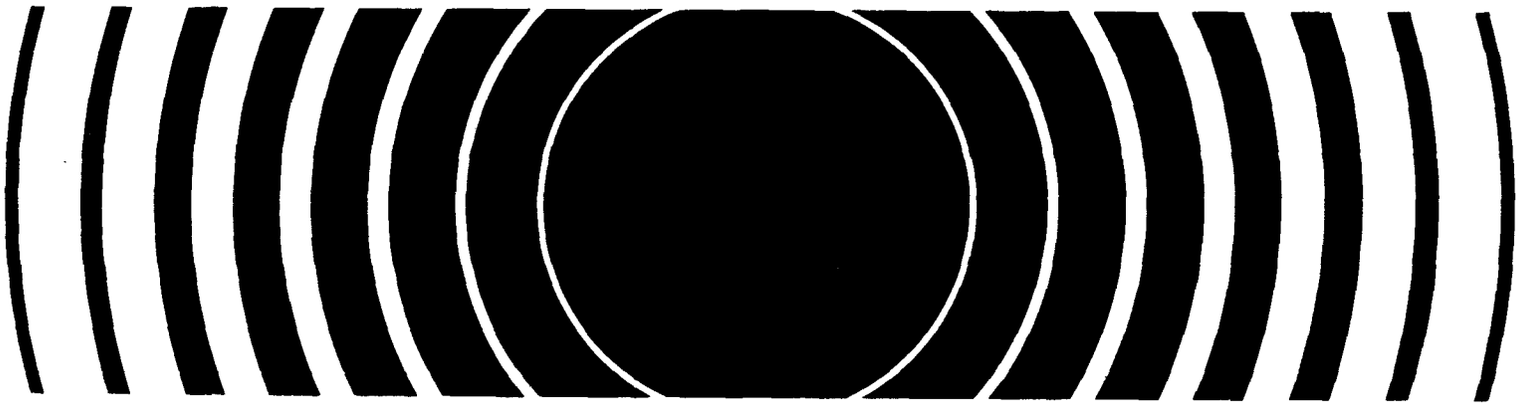
Office of Radiation Programs
Las Vegas Facility
P.O. Box 15027
Las Vegas NV 89114

ORP/EAD 79-2
March 1979

Radiation

EPA

An Investigation of Energy Densities in the Vicinity of Vehicles with Mobile Communications Equipment and Near a Hand-held Walkie Talkie



AN INVESTIGATION OF ENERGY DENSITIES IN THE VICINITY OF VEHICLES WITH MOBILE COMMUNICATIONS EQUIPMENT AND NEAR A HAND-HELD WALKIE TALKIE

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March 1979

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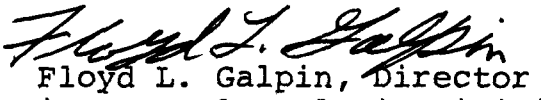
PREFACE

The Office of Radiation Programs of the U.S. Environmental Protection Agency carries out a national program designed to evaluate population exposure to ionizing and nonionizing radiation, and to promote development of controls necessary to protect the public health and safety. This report examines exposure levels in and around several varieties of vehicles equipped with mobile communications equipment and investigates exposure levels near the head of a walkie-talkie operator. Readers of this report are encouraged to inform the Office of Radiation Programs of any omissions or errors. Comments or requests for further information are also invited.



Floyd L. Galpin, Director
Environmental Analysis Division
Office of Radiation Programs

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ACKNOWLEDGMENT

The author wishes to thank Edwin Mantiply for his assistance in operating the communications equipment while measurements were being made.

A special thanks is due David Ball for his superb illustrations.

INTRODUCTION

With the rapidly increasing utilization of mobile communications equipment, an examination of potential exposure to persons in and around vehicles so equipped becomes of interest. This report studies exposure levels associated with a variety of vehicles equipped with 60 and 100 watt transmitters, broadcasting at 164.45 and 41.31 MHz respectively.

Measurements were made in the near vicinity (inside and outside) of each vehicle as well as at moderate distances (6 feet and 12 feet, two of the distances used in a recent citizen's band mobile radio study[1]). A variety of antenna locations were explored on similar vehicles. Special attention was given to those areas where persons might be located during transmissions. Maximum exposure levels were searched out at each given location. Measurements inside the vehicle were usually made with a subject seated in the area being measured if that site normally accommodated a person. This was done to take into account the body's field concentrating effects. A report by the National Bureau of Standards[2] showed maximum exposure levels occurred at sharp corners or edges, orifices such as wheel wells, and in the vicinity of a passenger's head; therefore, these areas were thoroughly examined. Comparisons were also made on vehicles with and without metallic shading screens on the rear window near the antenna mount.

A separate investigation was made of exposures around the head of a person operating a walkie-talkie.

INSTRUMENTATION AND EQUIPMENT

The survey instrument used in this investigation was one developed by the National Bureau of Standards. A detailed description of this unique device, model EDM-3, can be found in a previous EPA Technical Note[3]. The instrument measures energy densities from .03 to 3000 nJ/m^3 and is uniform over the frequency range 10 MHz to 1 GHz.

Two types of transmitters were used: the 60 watt Motorola Motrac at 164.45 MHz and the 100 watt General Electric MT74TDN22 at 41.31 MHz. The antennas used were either the ASP 446 base-loaded with 3dB gain or the Phelps Dodge 551-509 base loaded whip antenna with 2-1/2 dB gain.

The walkie-talkie was a Motorola HT-220, operating at 164.45 MHz with an output of 1.8 watts.

The vehicles investigated were selected from those used by the EPA for off-site monitoring or general purpose. A complete list is found in Appendix 1.

PROCEDURE

Two persons were involved in making measurements. One was located outside the vehicle with the NBS instrument; the other, seated inside the vehicle, keyed the transmitter and served as a representative driver or passenger whose presence would perturb the EM field. The sensing elements of the EDM-3 are in a small volume at the end of a rod approximately one meter in length. In order to measure inside the vehicle, the probe was inserted through an open window from a position outside so that only the transmitter operator perturbed the field. Furthermore because of erroneous measurements at closer distances, the sensing volume was kept greater than 2 inches from any surface. An attempt was made to read the meter scale to two significant figures; however, because of rapidly changing field strength over very short distances, it was often impossible to hold the sensing element steady enough to obtain a stable reading. Maximum values were often instantaneous peak readings which might vary 50 percent to 100 percent during the actual measurement due to small position fluctuations. No critical reading was recorded which could not be repeated when measured a second time. In many instances, both maximum and minimum values were recorded for a given area.

Although measurements were made in terms of electric field energy densities (nJ/m^3), they may be compared to the American National Standards Institute's standard for continuous occupational exposure ($40,000\ v^2/m^2$) by the expression: $U_E(nJ/m^3) = 0.00443E^2(v^2/m^2)^4$. In terms of electric field energy density, the standard becomes 177 nJ/m^3, which will be used as the reference standard here. It should be noted that the ANSI standard does not convert directly to OSHA's 10 mW/cm^2 value, which is applicable only to far field measurements. The ANSI standard was

conservatively derived to yield a rounded off number (194 v/m ≃ 200 v/m = 40,000 v^2/m^2).

An example of a data collection form is shown in Appendix 2. Values were recorded both on a tally sheet and on multiview vehicle drawings.

Exposures at the various body locations were usually determined with a subject sitting in the specified seat position. For comparison, a few measurements were taken with the seat empty. At all other locations inside and outside the vehicle, measurements were made without field disturbance by a person. Generally, only maximum readings were reported at locations outside each vehicle. In addition to making measurements close to the vehicle, exposures were defined at 6- and 12-foot distances, and at 3- and 6-foot heights above ground level.

A separate abbreviated investigation was made of exposure to the head from a hand-held walkie-talkie. The unit had a 5-inch antenna mounted just above the speaker/microphone. During measurement it was held normally, in the right hand, which placed the antenna directly opposite and about 2-3 inches from the operator's right eye (Figure 1).

RESULTS

VEHICLES

Measured values have been tabulated separately for passenger cars, pickup trucks and vans (Tables 1, 2, and 3). Furthermore, each table is divided into four major groups of measurements; those made inside the vehicle where persons may be seated, other measurements inside the vehicle (both of these groups are illustrated in Figures 2-14), major sites outside but close to the vehicle (illustrated in Figures 15-33) and those made at various distances from each vehicle. In Tables 1, 2, and 3; single numbers represent maximum observed values in the given area, numbers separated by a dash (e.g., 0.1-1.1) are minimum and maximum values observed in the same general area; numbers separated by a slash (e.g., 2.0/18) are the smallest and largest maximum values observed in more than one similar area such as wheel wells, windows, and potential locations for gas tank fillers. (In the case of gas tank fillers, three readings were made: one at the actual location of the filler, and two more where gas fillers might be on different makes of similar vehicles.) Each table is arranged so that the same area in similar vehicles may be compared directly.

Looking at the inside of each vehicle where persons would be sitting (Figures 2-14), in most cases, maximum exposures occur in the vicinity of the head and near the driver's hands (when on the steering wheel).

The head area was explored in greater detail as shown in Figures 12 to 14. Here, the highest values (up to 120 nJ/m^3) were observed in pickup truck cabs, the lowest (1.0 nJ/m^3), in

one of the sedans and one of the vans. An interesting variation is seen in pickup #1 having a metallic screen in the rear window (Figure 13a). When the screen is removed, exposure to the head approximately doubles. Other comparisons of head exposures may be made, most of which show expected results. Exposures are lower in the standard sedan with a 60 watt transmitter (Figure 12a) than in the compact sedan with 100 W transmitter (Figure 12c), antennas being in comparable locations. This is probably due not only to the higher power output, but also to more extensive roof shielding in the larger sedan. Exposures in the region where the driver's head would be in the station wagon when the seat is empty are substantially less than those when the seat is occupied (Table 1 and Figure 12b). A similar comparison in a pickup truck cab, but looking at other regions of the body, (Table 2, Truck 3) does not show the same relative reduction as was just noted in the head region of the station wagon. This is probably caused by the seat position with respect to the antenna (mounted above rear window in the pickup truck). The presence of the body, in addition to concentrating the field at the head, also causes shielding in the gonadal area. The importance of antenna position is clearly seen in Figure 13. Those trucks having a roof mount (Figure 13a, b, and c) show head exposures 5 to 20 times greater than the one with a rear fender mount (Figure 13d). There is also less head exposure if the antenna is in the center of the roof (Figure 13c) rather than near the rear window (Figure 13d and b). Values measured inside the two vans (Table 3 and Figure 14) show relatively low readings, similar to those in the Plymouth sedan (Table 1 and Figure 12a). This is undoubtedly due to the relatively large roof area. A notable exception occurs in the modified Chevrolet van at the driver's position. Here, the antenna is directly in front of the driver, with the most intense field occurring about 1-2 feet above his head. The head exposure is significantly greater if the driver stands up with his head above the metal frame inside the fiber glass ceiling (Figure 11 and Figure 14b).

Other areas inside each vehicle where exposures are consistently higher than average include the steering wheel and rear view mirror (windshield mount). The peak exposure in each case is generally defined by very small dimensions, falling off rapidly within an inch or two.

Window areas were measured in two ways. If the window was fixed, measurements were made both on the inside and outside. Where the window was a roll-down type (side window) measurement was made once only with the window in the down position. All side window measured values are shown on outside view figures (Figures 15-32). Most windows had one "hot" spot, usually within 2 inches of the top boundary and near the center (Figures 19, 22, 32). Again, this "hot" spot was defined within a small area.

The sites showing lowest exposure levels occurred in areas most effectively shielded from the antenna - usually away from window areas. Included are foot wells, the gonadal area of a subject (body shielding), and inside luggage compartments or truck beds.

Areas outside, but in the near vicinity of the vehicle, which showed above average exposure levels included some wheel wells, certain sharp or well defined corners or edges, and protuberances such as gas caps, door handles and rear view mirrors. The 1971 Chevolet van (Table 3, Figures 32 and 33) showed a single highly elevated level of 400 nJ/m^3 near the cowl mounted antenna. The highest values not directly at the antenna site occurred on a pickup truck with a rear mounted antenna (Truck #4, Table 2, Figures 28 and 29). Here, the sharp corners of the rear fenders measured 120 nJ/m^3 and the left rear wheel well, 72 nJ/m^3. The position of the antenna apparently influences these exposures. The 72 nJ/m^3 value for the left rear wheel well is in contrast to the right front wheel well's 2.0 nJ/m^3, a remote location with respect to the antenna. Antennas located

more centrally produce more uniform exposure levels at similar sites (e.g., wheel wells and bumpers).

Outside exposures of the 1976 Ford Maverick sedan (Figures 19, 20 and 21) were defined in greater detail than those for the other sedans, as the measured field intensities were highest for this vehicle (it was smaller than the other sedans and had the highest transmitter power output). With the antenna mounted in the direct center of the roof top, exposures are noticeably symmetrical about the vehicle. Highest levels were predictably at protuberances (bumpers, door handles, and outside mirrors), fender edges, the top center areas of windows, and near the antenna. A diagram of the roof (Figure 21) shows that at distances closer than 6 inches to the antenna, equivalent occupationally defined exposure limits may be exceeded (177 nJ/m^3).

Exposures measured at distances of 6 and 12 feet from each vehicle were considerably lower than those measured at the vehicle. Average exposures were about 0.5 nJ/m^3 with maximum values of 1 to 2 nJ/m^3.

HAND-HELD WALKIE TALKIE

The separate investigation of exposures resulting from the operation of a hand-held walkie talkie shows a maximum energy density to the head area of greater than 200 nJ/m^3 (Figure 34). This exposure was found near the eye closest to the antenna. The exposure rapidly diminishes by a factor of 10 within 1 or 2 inches of the maximum exposure site.

SUMMARY AND CONCLUSIONS

Electric field energy densities were investigated in and around nine separate vehicles using mobile communications equipment, as well as in the near vicinity of a hand-held walkie talkie.

The only instances in which the current ANSI standard (177 nJ/m^3) was exceeded occurred within 6 inches of an active antenna. In most cases, the antenna was installed at a point on the vehicle where human contact or approach within 6 inches would be minimized (roof mounts). Two vehicles had antennas on or near fenders where exposure levels exceeding 177 nJ/m^3 to part of the body would be possible. In the case of the cowl mounted antenna on the Chevrolet van, high exposures to the head area would be possible to a person working in the windshield area (e.g., washing windows). The most likely event leading to exposures exceeding 177 nJ/m^3 occur with the hand-held walkie talkie (200 nJ/m^3 at the eye). The current standards reflect occupationally acceptable levels. It might be well to note that several other areas, inside and outside of each vehicle, as well as near the walkie talkie, showed exposures exceeding 10 percent of the current standard (17.7 nJ/m^3). Of the major sites measured and tabulated in the near vicinity of passenger sedans, about 5 percent of exposures exceeded 18 nJ/m^3. Approximately 10 percent of the measured values close to and inside the two vans exceeded 18 nJ/m^3 and nearly 40 percent of those associated with pickup trucks exceeded that value. Exposure levels at 6 feet or greater from any vehicle were much lower than 18 nJ/m^3. Since the two carrier frequencies investigated (41.31 MHz and 164.45 MHz) were transmitted with 100 W and 60 W respectively, it is believed that these

measured exposures represent maximum probable exposure from typical mobile communications systems.

The walkie-talkie is representative of a "worst case" situation, having the antenna located within 3 inches of an eye.

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TABLE 1
ENERGY DENSITIES MEASURED (nJ/m^3)

Passenger Cars

Location Measured	Standard Sedan 60W/164.45 MHz Roof,Center-Mounted Antenna	Station Wagon 60W/164.45 MHz Roof,Center,Rear-Mounted Antenna	Compact 100W/41.31 MHz Roof,Center-Mounted Antenna
Inside Vehicle			
Driver			
1. Feet	0.7 - 1.0	1.0 - 7.0 (.27)	0.5
2. Knees	1.0 - 4.5	7.0 - 3.0 (.3-.5)	2-8
3. Gonads	1.6	1.4 - 2.3 (.2-.3)	0.5
4. Chest	0.7	2.6 - 6.3 (.2-1.0)	0.5 - 3.4
5. Hands	1.0 - 8.0	4.2 - 8.4 (.5-1.9)	5-12
6. Head	0.4 - 1.5	1.0 - 3.0 (.4-.8)	1-20
Passenger (Rt. Front)			
1. Feet	0.1 - 1.1	0.1 - 0.2	0.3
2. Knees	1.0 - 4.1	0.2 - 1.7	0.2 - 0.8
3. Gonads	0.2 - 0.5	0.15- 0.4	0.1
4. Chest	0.6 - 1.1	2.0 - 6.0	0.2 - 1.1
5. Hands	0.4 - 1.1	1.2 - 2.4	0.2
6. Head	0.3 - 3.0	2.0 - 7.0	1.0 - 13
Passenger (Rt. Rear)			
1. Feet	0.1	0.5 - 1.5	0.6 - 1.0
2. Knees	0.4	0.5 - 4.4	1.6
3. Gonads	0.2	0.8	0.1
4. Chest	0.2 - 0.6	0.7 - 1.7	1.0
5. Hands	0.3 - 0.8	0.2 - 1.0	0.2 - 1.0
6. Head	0.5 - 2.0	0.5 - 2.5	0.5 - 6.0
Passenger (Lft. Rear)			
1. Feet	0.3	0.05- 0.1	1.1
2. Knees	4.0	0.4 - 4.5	1.2
3. Gonads	0.1	<0.1	1.1
4. Chest	0.4	0.2 - 1.1	1.2
5. Hands	0.2 - 0.3	0.2	0.2 - 0.8
6. Head	0.3 - 4.0	0.8 - 1.4	6.4

TABLE 1 (Continued)
ENERGY DENSITIES MEASURED (nJ/m^3)

Passenger Cars

Location Measured	Standard Sedan 60W/164.45 MHz Roof,Center-Mounted Antenna	Station Wagon 60W/164.45 MHz Roof,Center,Rear-Mounted Antenna	Compact 100W/41.31 MHz Roof,Center-Mounted Antenna
Inside Vehicle			
Windshield	2.0 -13.0	2.0 -17.0	4.0 - 20
Rear Window	1.0 -10.0	3.0 -10.0	4.0
Glove Box	4.4	0.5 - 1.0	0.4 - 1.0
Trunk/Storage	0.5 - 1.5	0.8 - 7.0	-
Instrument Cluster	0.2 - 5.0	0.5 - 3.0	0.2 - 1.0
Rear Deck	1.0 - 4.0	-	2.0
Side Windows	1.0 /12.0	2.0 /18.0	14.0
Outside Vehicle			
Wheel Wells	0.6 / 0.84	0.6 / 1.3	2.0 / 6.0
Gas Tank Filler	2.0 / 2.5	2.2 / 2.5	10 / 15
Windshield	1.0 - 7.0	2.0 - 9.0	20.0
Rear Window	1.0 -10.0	10.0	9.0
Front Grill/Hood/ Bumper	1.0 - 4.0	0.5 - 2.8	16.0 - 20.0
Trunk Lid/Bumper	1.5 - 9.0	0.4 - 3.8	12.0 - 20.0
Circumference			
6' @ 3' Height	0.3 - 0.8	0.2 - 0.9	0.2 - 0.6
6' @ 6' Height	0.2 - 0.7	0.6 - 1.7	0.1 - 0.6
12' @ 6' Height	0.2	0.3 - 0.9	-
Roof Near Antenna			
<6" from antenna			3000 plus
∿6" from antenna			100
∿12" from antenna			50
Edge of Roofline			20/30

TABLE 2
ENERGY DENSITIES MEASURED (nJ/m^3)

Pickup Trucks

Transmitter Power = 100W
Frequency = 41.31 MHz

Truck #:	#1		#2	#3	#4
Antenna:	Roof		Roof	Roof	Fender
Location:	Rear		Rear	Center	Rt.-Rear (Whip)
	Screened Rear Window Without Screen	(With Screen)			
Inside					
Driver					
1. Feet		(0.2 - 0.8)	2.6	1.4	0.6
2. Knees		(2.0 - 4.0)	8.6	6.0	1.4
3. Gonads		(0.2 - 0.4)	10.0	5.0	4.0
4. Chest		(0.2 - 2.2)	1.2	1.5	0.6
5. Hands	2.0 -30	(0.2 -40)	60	40	5.0
6. Head	4.0 -85	(2.0 -41)	120	30	6.0
Driver #2					
1. Feet		(0.5)			
2. Knees		(1.5)			
3. Gonads		(0.3)			
4. Chest		(0.3 - 2.2)			
5. Hands		(2.0 -20)			
6. Head		(2.0 -32)			
Passenger				(Seat Empty)	
1. Feet	0.3	(0.5)	2.9	1.5(0.4)	0.05
2. Knees	0.5 - 1.6	(1.5)	6.2	4.0(0.4)	0.5
3. Gonads	0.1 - 0.2	(0.5)	1.2	1.5(4.8)	"0"
4. Chest	1.8 - 6.0	(.6 - 1.2)	1.7	2.2(2.5)	0.15
5. Hands	1.0 - 1.7		2.3	1.4(2.4)	0.5
6. Head	4.0 -62		72	30 (5.5)	4.0
Windshield	35		72	48	12.0
Rear Window	45		48	19	10.0
Glove Box	2.0 -11		18	19	0.3
Dash	0.5 - 3.0		4.0	19	0.6
Side Windows	23		17/21	14	3.6/9.0

TABLE 2 (Continued)
ENERGY DENSITIES MEASURED (nJ/m^3)

Pickup Trucks

Transmitter Power = 100W
Frequency = 41.31 MHz

Truck #:	#1	#2	#3	#4
Antenna:	Roof	Roof	Roof	Fender
Location:	Rear	Rear	Center	Rt.-Rear (Whip)
Outside				
Wheel Wells	1.0 /10.0	8.0 /75	2.7 /19	1.0 /72
Gas Tank Filler	8.0 /24.0	30 /80	4.8 /13	12 /38
Windshield		68	48	12.0
Rear Window		72	19	12.0
Front Grill/Hood/ Bumper	14 -38	70	32	12
Rear Storage/ Bumper	8.0 -22	3.0 -60	8 -22	120
Circumference				
6' @3' Height	0.4 - 0.8	0.4 - 0.9	0.8 - 1.4	0.2 - 1.2
6' @ 6' Height	0.5 - 1.3	0.4 - 1.1	1.0 - 2.2	0.8 - 1.2
12' @ 6' Height	0.1 - 0.6	0.1	0.4 - 0.6	0.1 - 0.4

TABLE 3
ENERGY DENSITIES MEASURED (nJ/m^3)

Vans

60W/164.45 MHz

Antenna:	1973 Dodge Standard No Side or Rear Windows Roof-Center Over Cab Base Loaded	1971 Chevrolet Modified High Fiberglass Roof One Side Window Left Front Cowl Whip
Location		
Inside		
Driver		
1. Feet	0.2	0.8 - 2.0
2. Knees	1.0	1.6 - 4.0
3. Gonads	0.2 - 0.8	3.0 - 4.0
4. Chest	0.2 - 0.4	0.8 - 2.2
5. Hands	0.2 - 0.9	2.0 -10.0
6. Head	0.3 - 2.5	2.4 - 7.0
Standing	-	40 (Head in Fiberglass Section)
Passenger		
1. Feet	0.2	0.8 - 1.8
2. Knees	0.1 - 0.4	2.0 - 3.0
3. Gonads	0,2 - 0.4	1.5
4. Chest	<0.2 - 0.4	1.2
5. Hands	0.1 - 0.8	2.0 - 3.0
6. Head	0.3 - 1.0	0.5 - 2.5
Windshield	0.3 - 1.8	5.0 -13
Glove Box	0.5	13
Instruments	0.5 - 1.5	4 -10
Interior		
Front	40 max (near AC)	13
Rear	<0.2	13
Side Windows	0.5 / 2.8	2.0 / 2.5

TABLE 3 (Continued)
ENERGY DENSITIES MEASURED (nJ/m^3)

Vans

60W/164.45 MHz

Antenna:	1973 Dodge Standard No Side or Rear Windows Roof-Center Over Cab Base Loaded	1971 Chevrolet Modified High Fiberglass Roof One Side Window Left Front Cowl Whip
Location		
Outside		
Wheel Wells	0.1 / 0.5	0.1 /18
Gas Tank Filler	<0.1 / 2.0	<0.1 / 3.0
Windshield	1.0 - 6.0	10-400 (near antenna)
Rear Window	-	2.5
Front Grill/Hood	0.5 - 3.0	1.0 -32
Rear Area	-	0.1
Circumference		
6' @ 3' Height	0.1 - 0.4	<0.1 - 0.4
6' @ 6' Height	0.2 - 0.7	0.4 - 1.4
12' @ 6' Height	0.1 - 0.2	0.2 - 0.4

Figure 1. Position of Hand-held Walkie Talkie During Energy Density Measurements

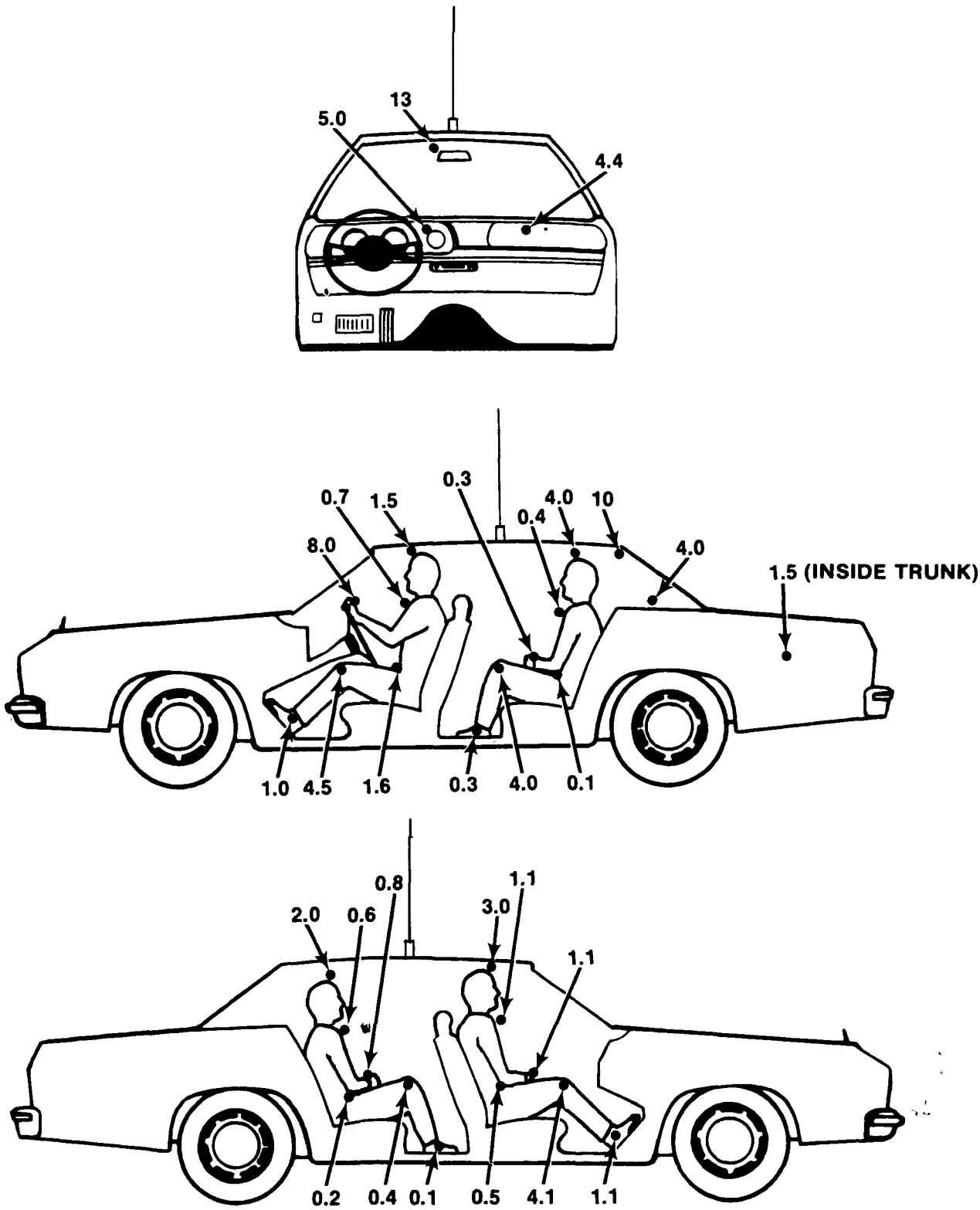


Figure 2. Maximum Energy Densities (nJ/m^3)
1973 Plymouth Fury 4-Door Sedan (Interior)
Transmitter: 60 watts, 164.45 MHz

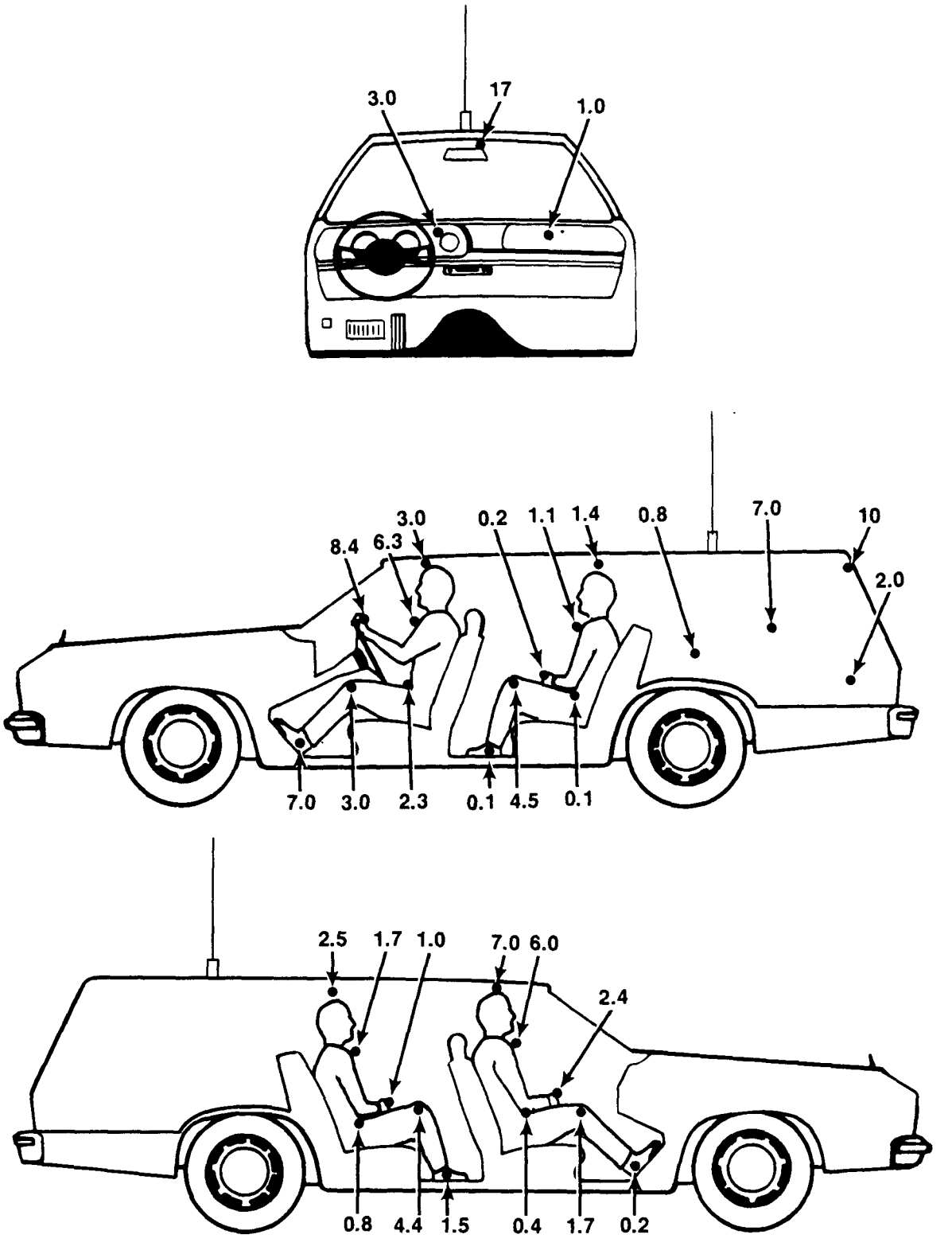


Figure 3. Maximum Energy Densities (nJ/m^3)
1974 Ford Torino Station Wagon (Interior)
Transmitter: 60 watts, 164.45 MHz

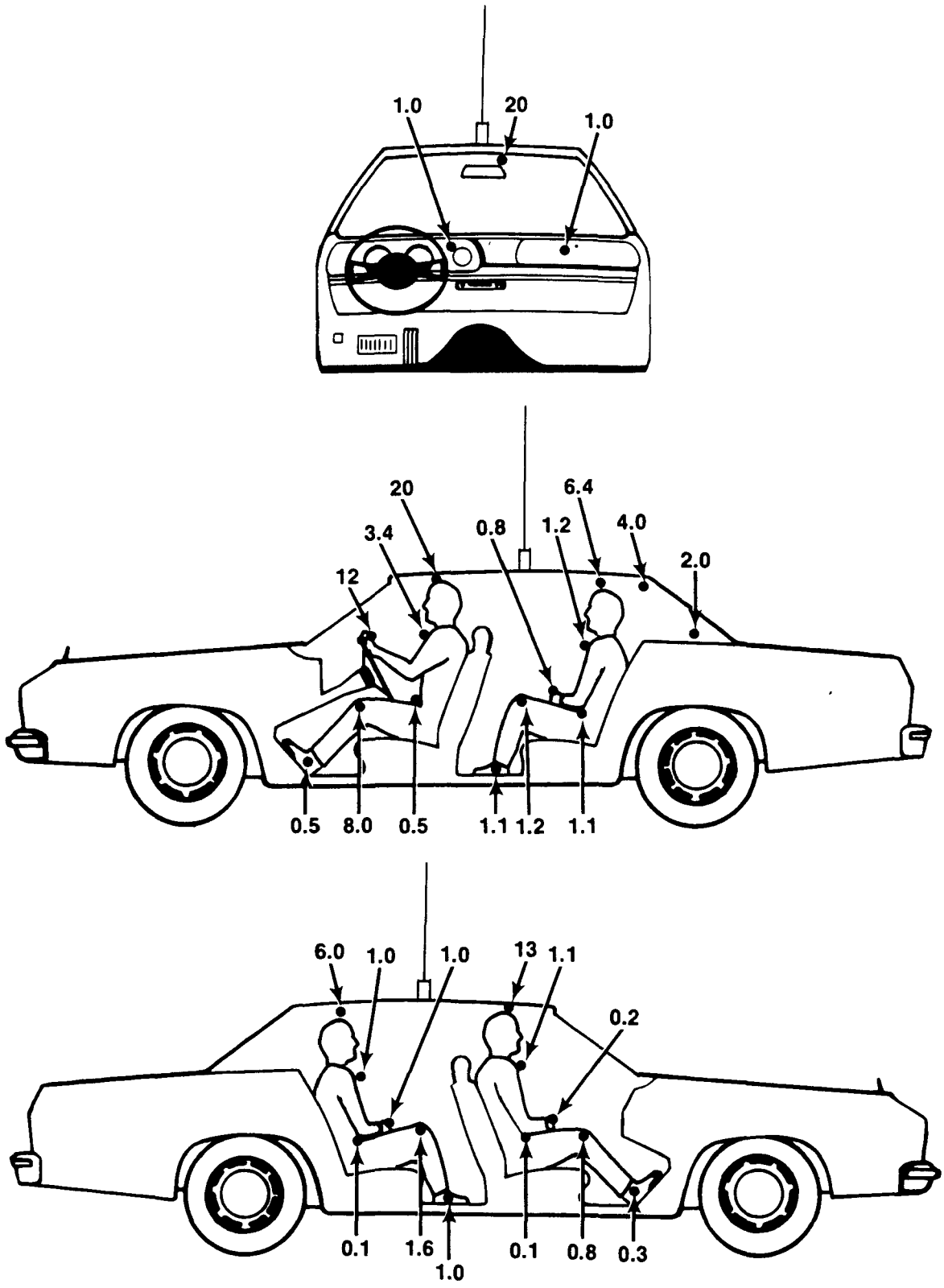


Figure 4. Maximum Energy Densities (nJ/m^3)
1976 Ford Maverick 4-Door Sedan (Interior)
Transmitter: 100 watts, 41.31 MHz

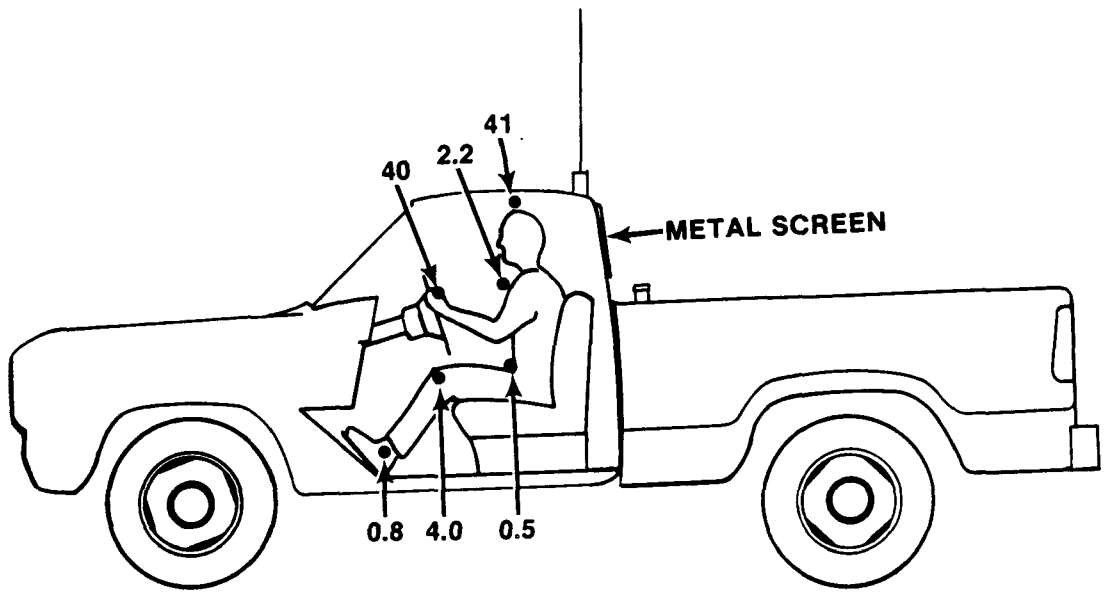


Figure 5. Maximum Energy Densities (nJ/m^3)
Interior of Truck #1 (1973 Dodge D200)
Rear window screen in place
Transmitter: 100 watts, 41.31 MHz

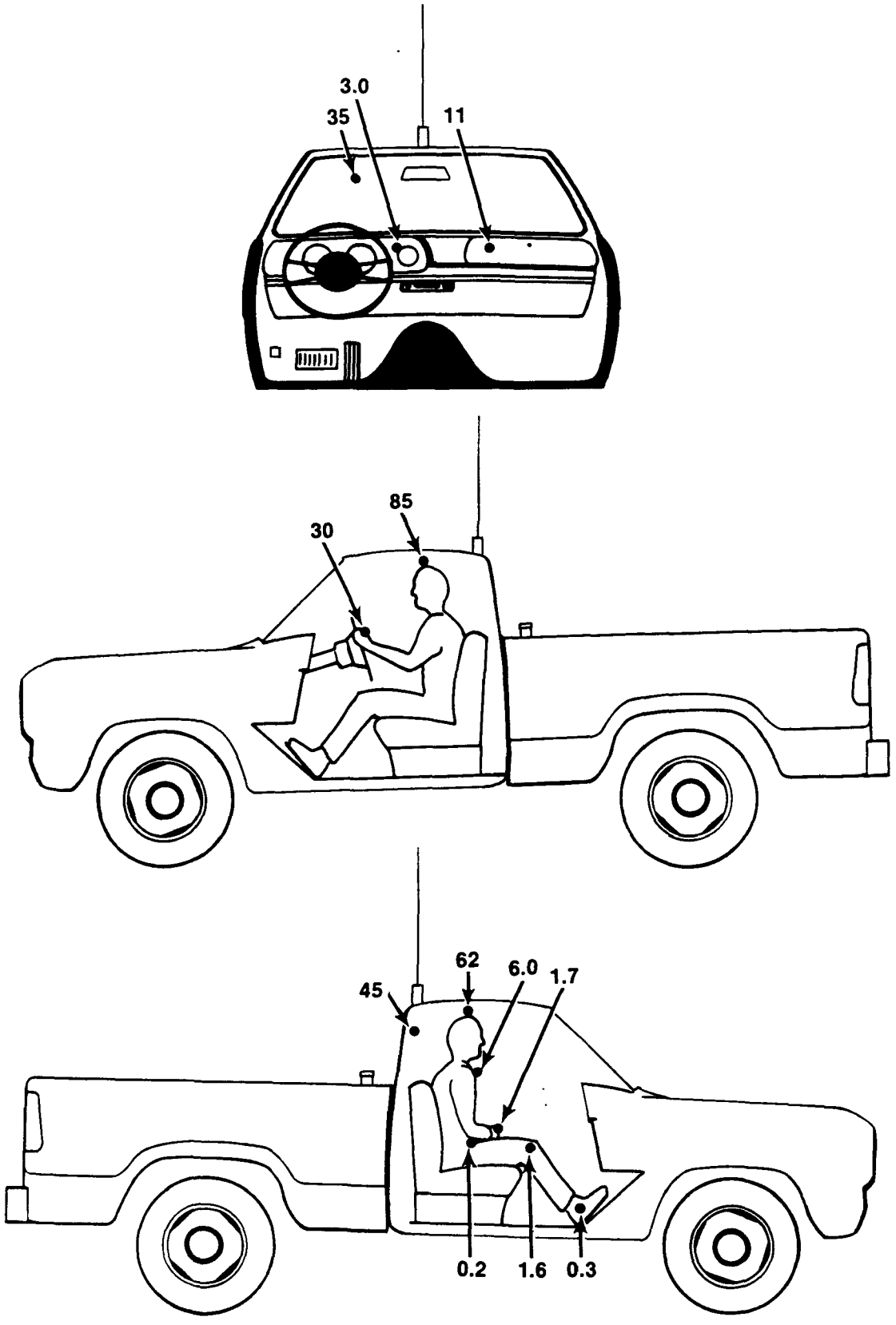


Figure 6. Maximum Energy Densities (nJ/m^3)
Interior of Truck #1 (1973 Dodge D200)
Rear window screen removed
Transmitter: 100 watts, 41.31 MHz

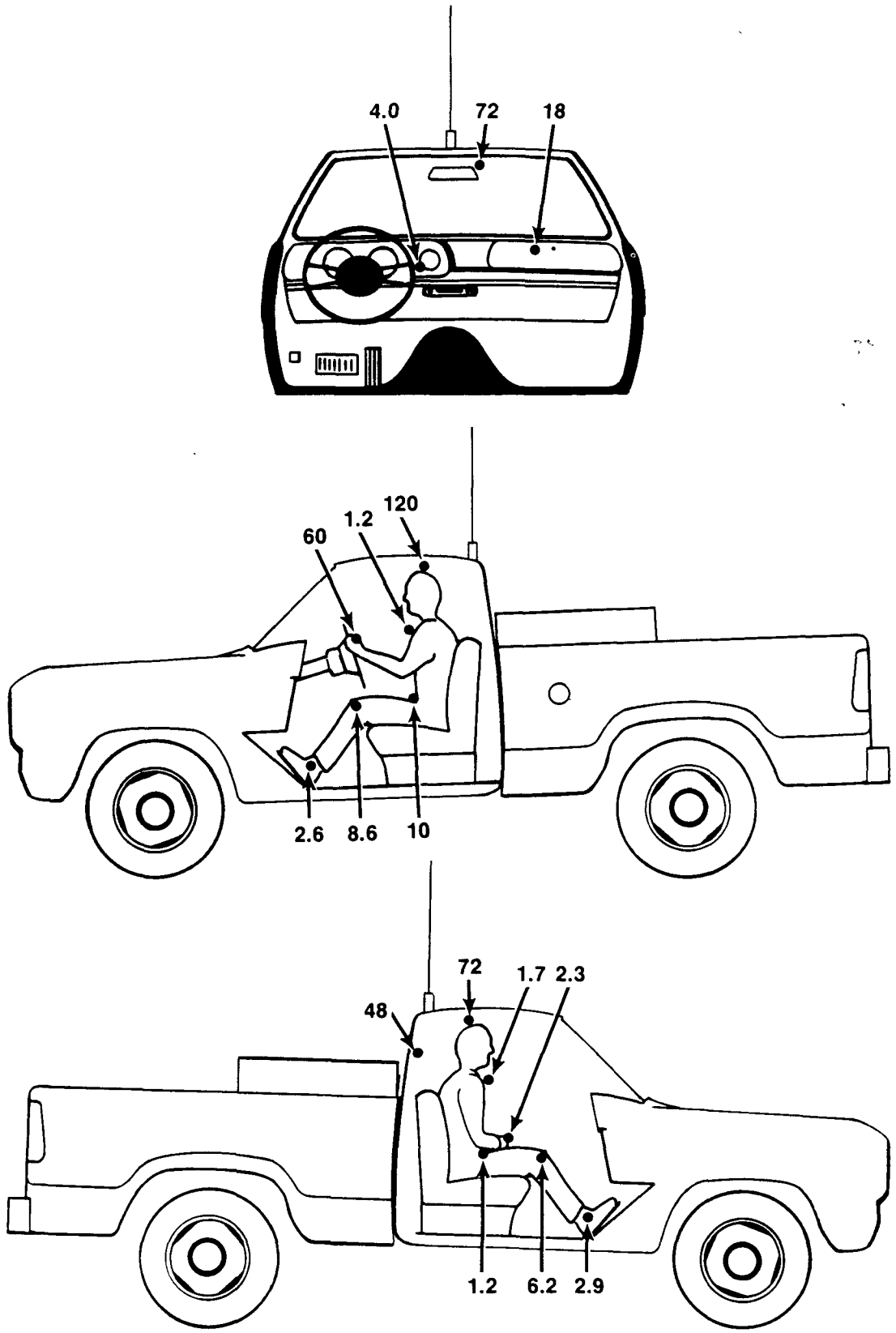


Figure 7. Maximum Energy Densities (nJ/m^3)
Interior of Truck #2 (1978 Dodge Power Wagon 150)
Transmitter: 100 watts, 41.31 MHz

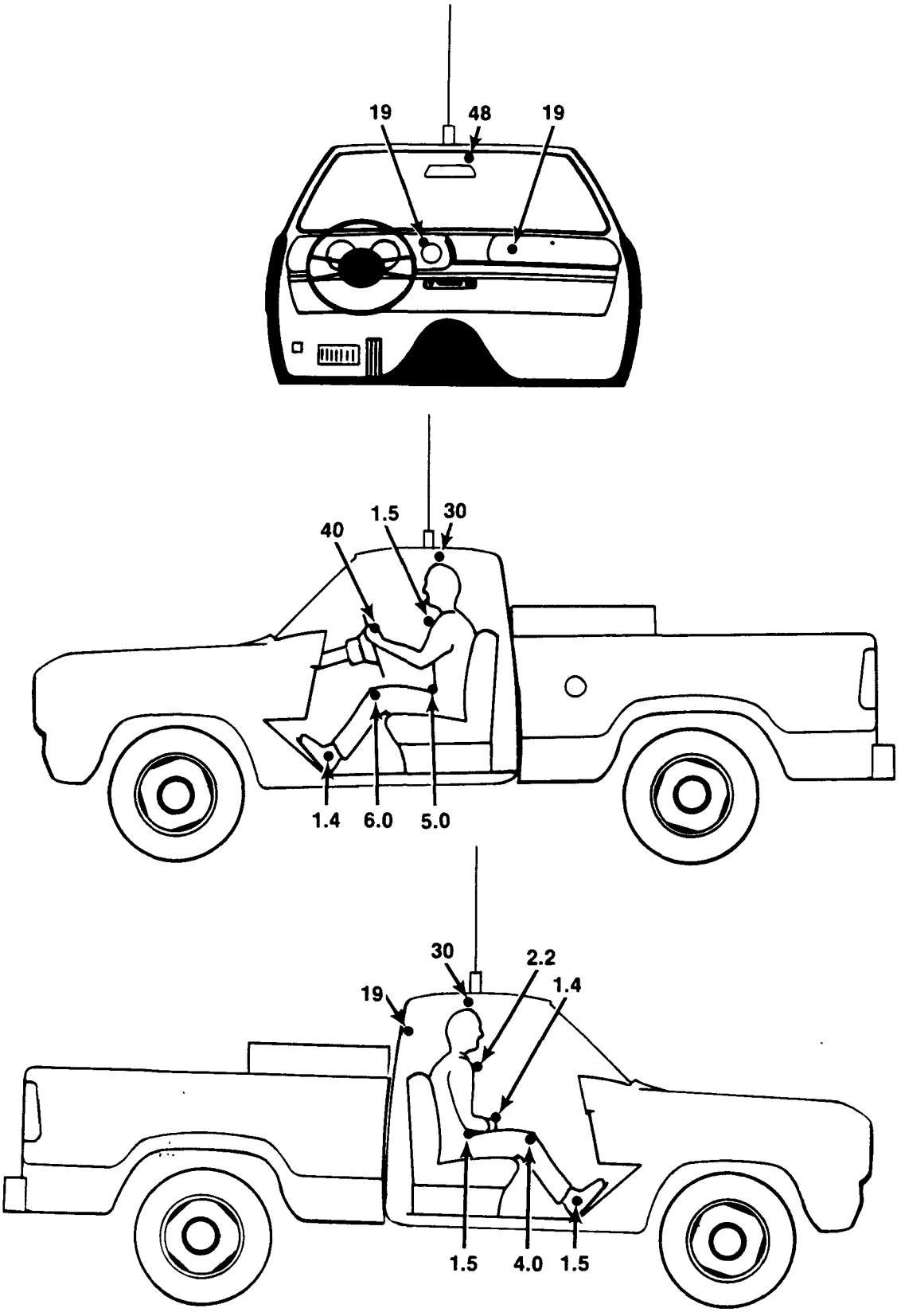


Figure 8. Maximum Energy Densities (nJ/m^3)
Interior of Truck #3 (1978 Dodge Power Wagon 150)
Transmitter: 100 watts, 41.31 MHz

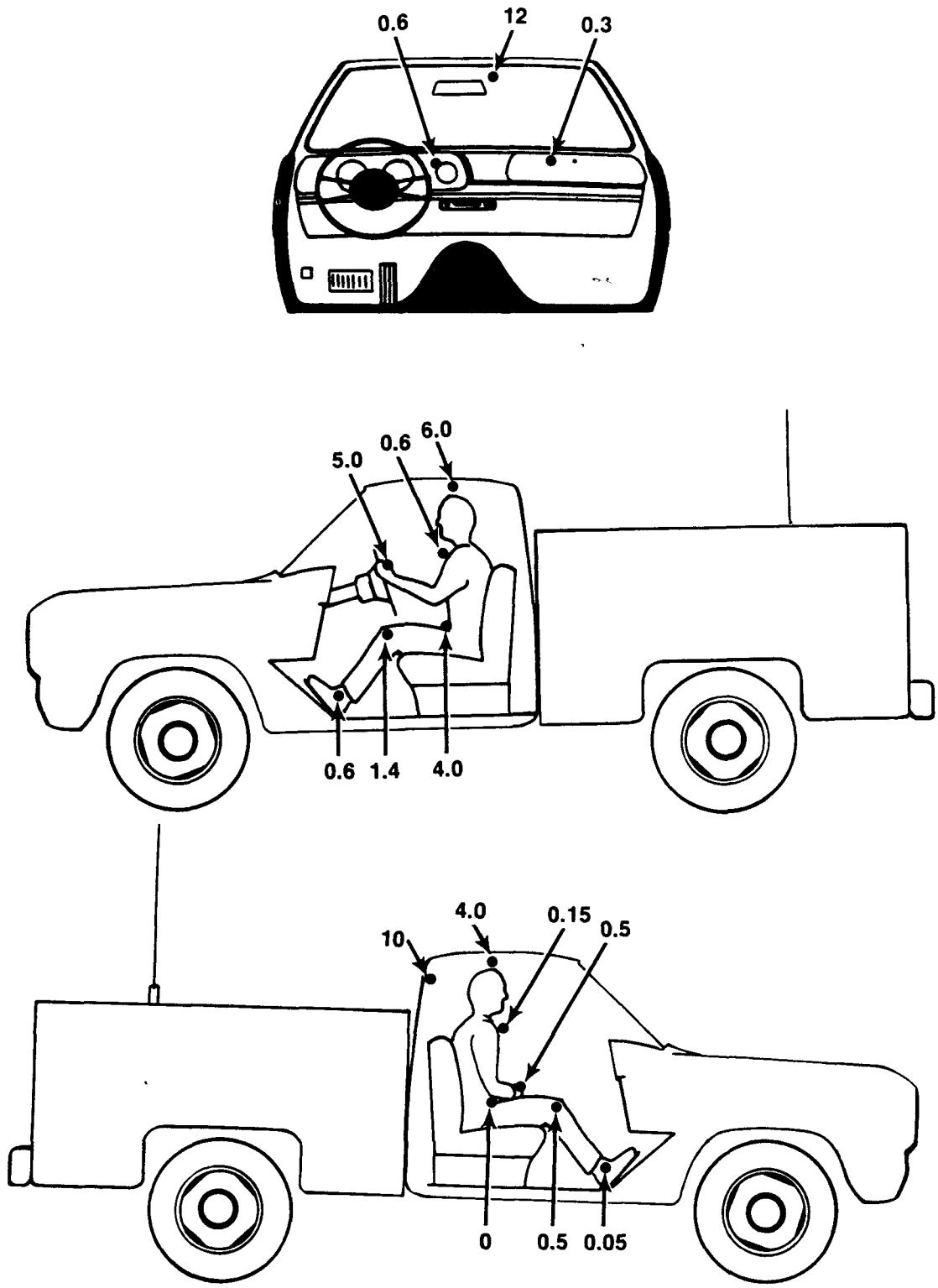


Figure 9. Maximum Energy Densities (nJ/m^3)
Interior of Truck #4
(1977 Chevrolet Custom Delux 20)
Transmitter: 100 watts, 41.31 MHz

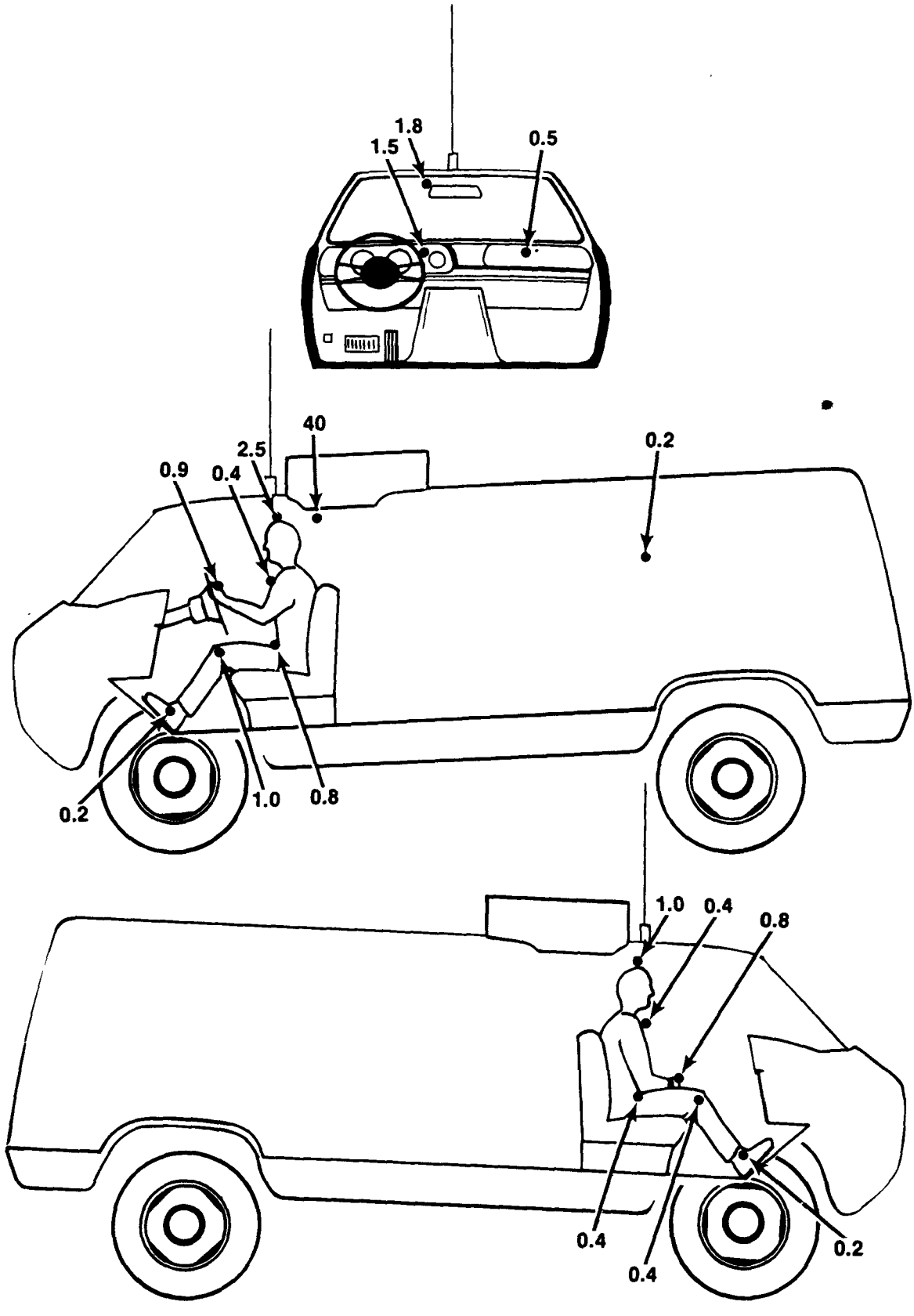


Figure 10. Maximum Energy Densities (nJ/m^3)
1973 Dodge Tradesman 300 (Interior)
Transmitter: 60 watts, 164.45 MHz

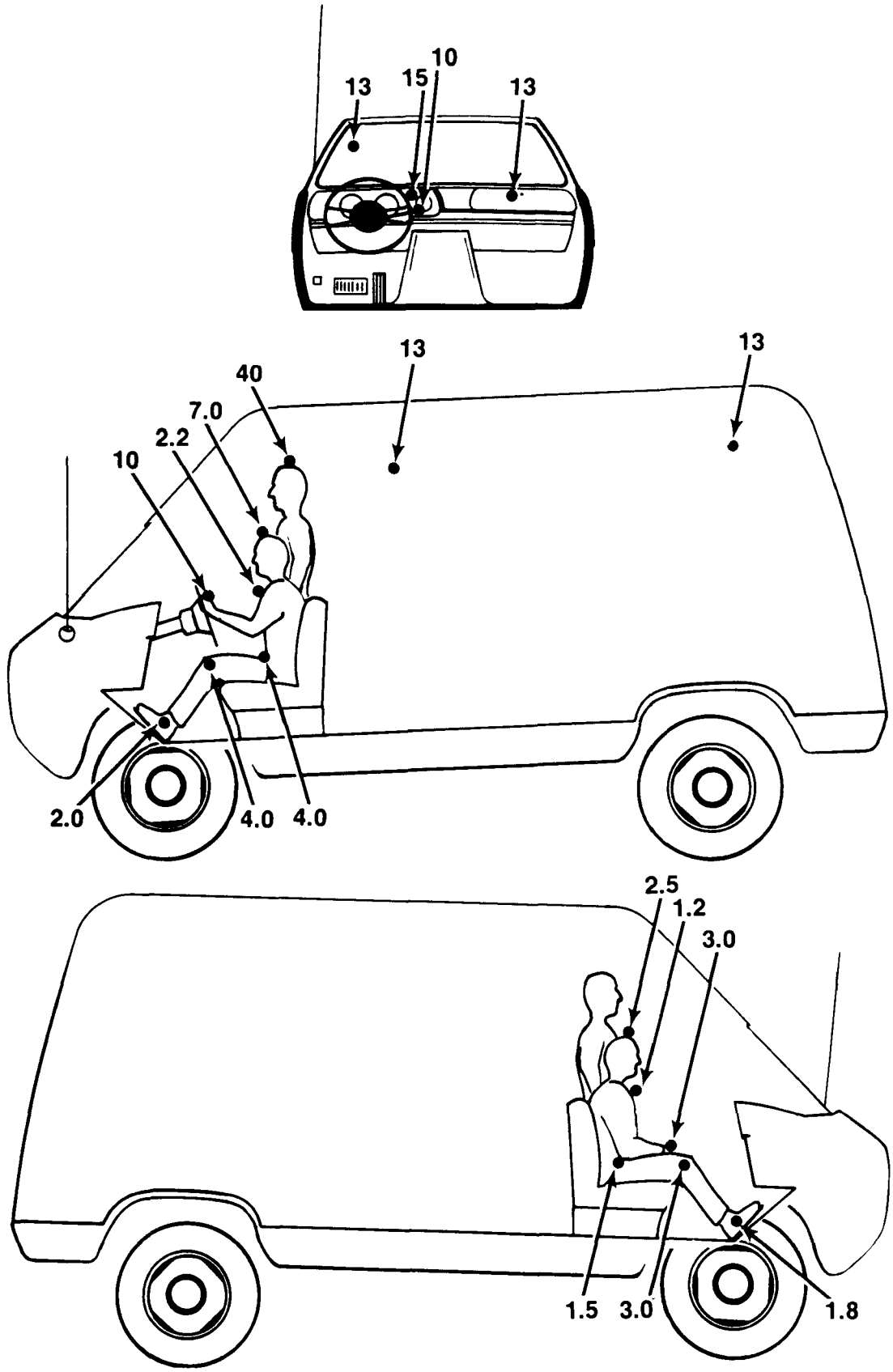
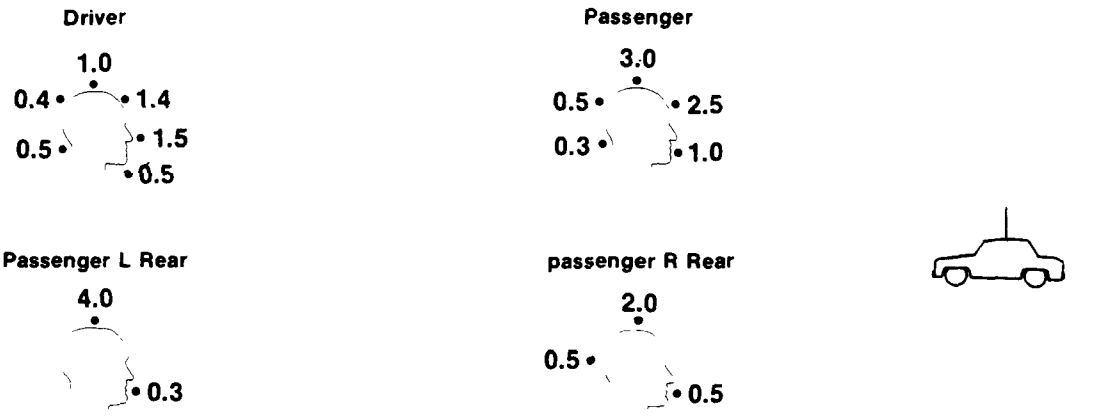


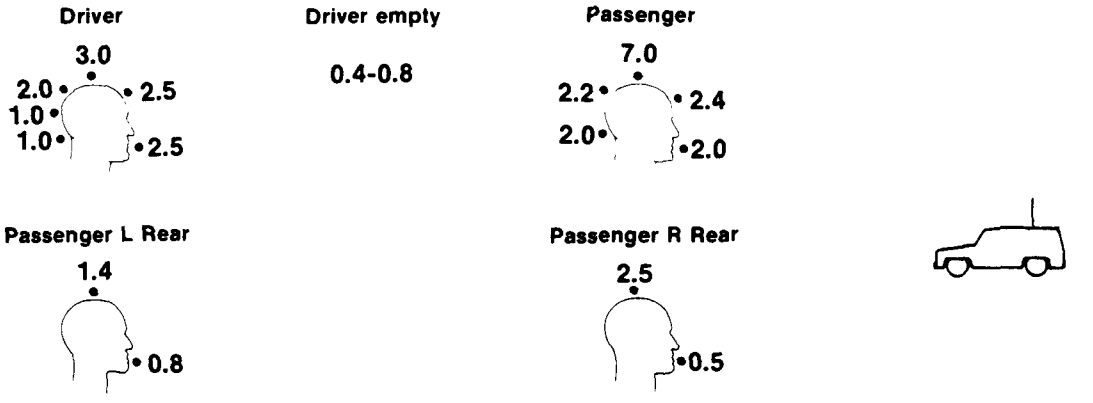
Figure 11. Maximum Energy Densities (nJ/m^3)
1971 Chevrolet Chevyvan 30 (Interior)
Transmitter: 60 watts, 164.45 MHz

EXPOSURE TO HEAD AREAS IN SEDANS

A. 1973 Plymouth Fury-4 door sedan 60W/164MHz



B. 1974 Ford Torino station wagon 60W/164MHz



C. 1976 Ford Maverick-4 door compact sedan 100W/41MHz

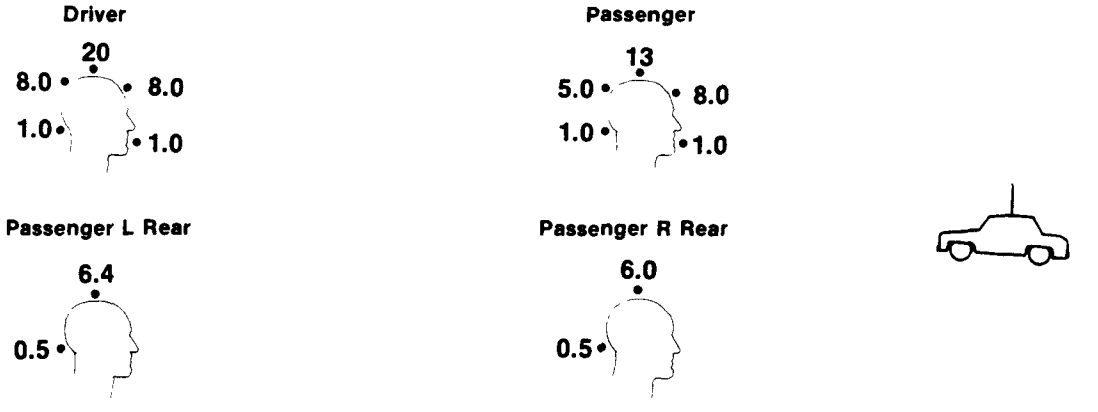


Figure 12. Exposure to head areas of passengers in sedans (nJ/m^3)

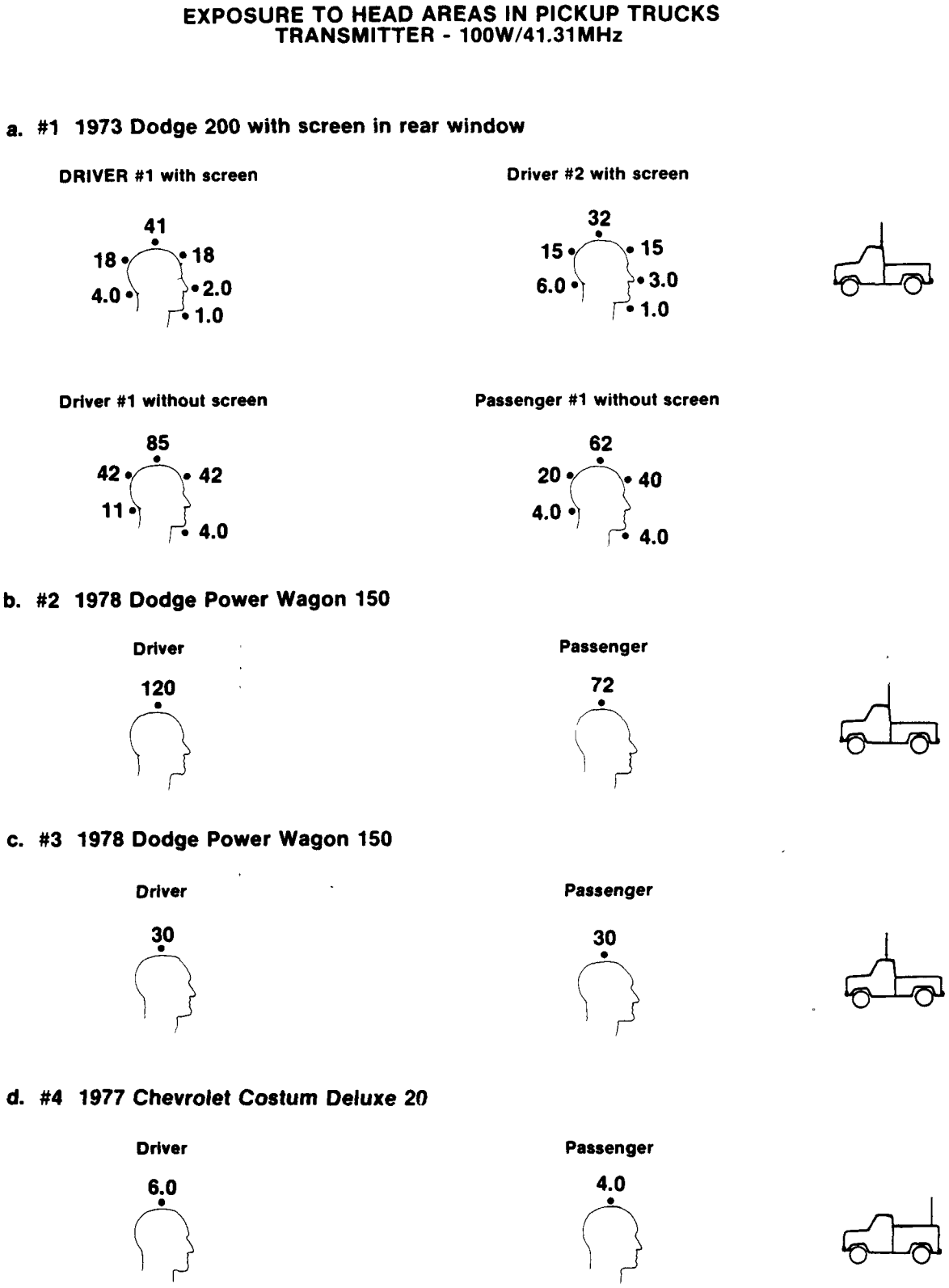
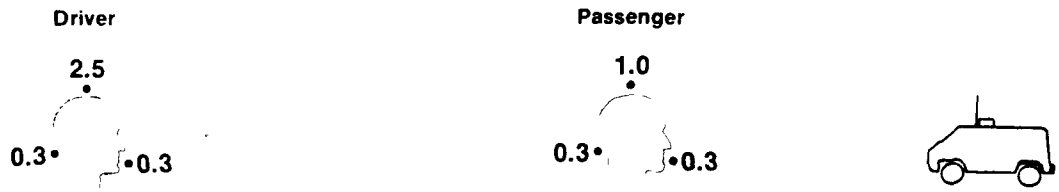


Figure 13. Exposure to head areas of passengers in pickup trucks (nJ/m^3)

EXPOSURE TO HEAD AREAS IN VANS
TRANSMITTER-60W/164.45 MHz

A. 1973 Dodge Tradesman 300 (no windows in rear section)



B. 1971 Chevrolet Chevyvan 30 with fiberglass top

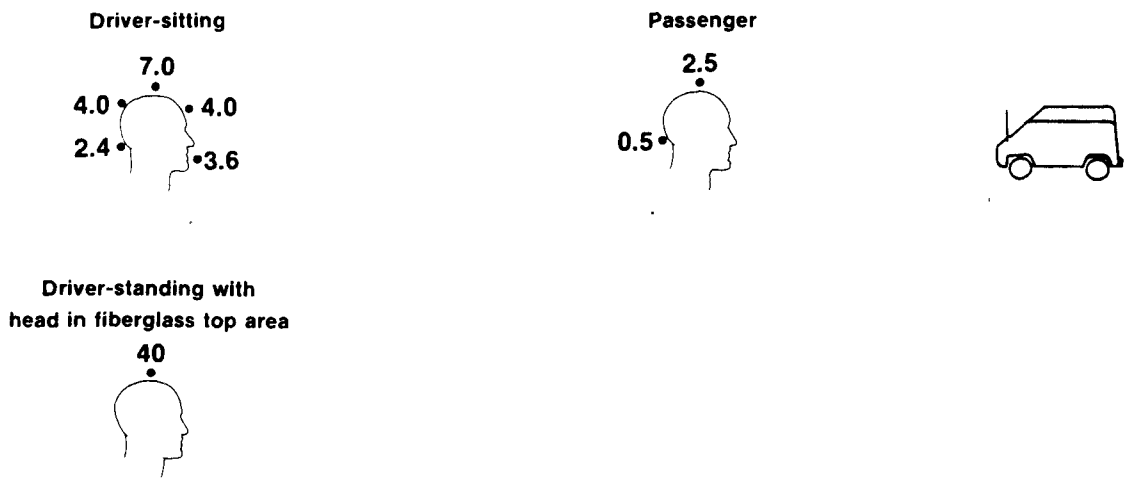


Figure 14. Exposure to head areas of passengers in vans (nJ/m^3)

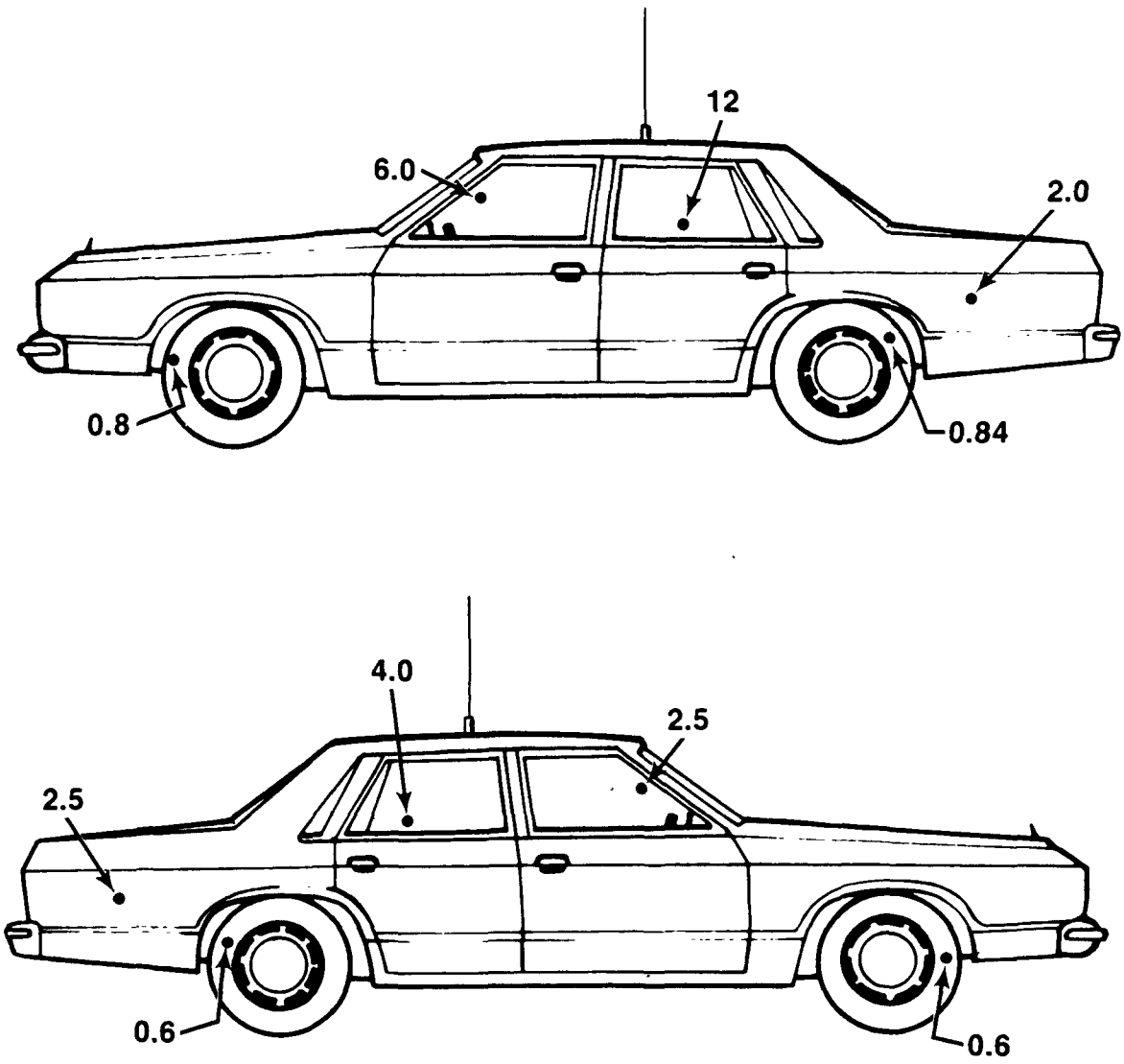
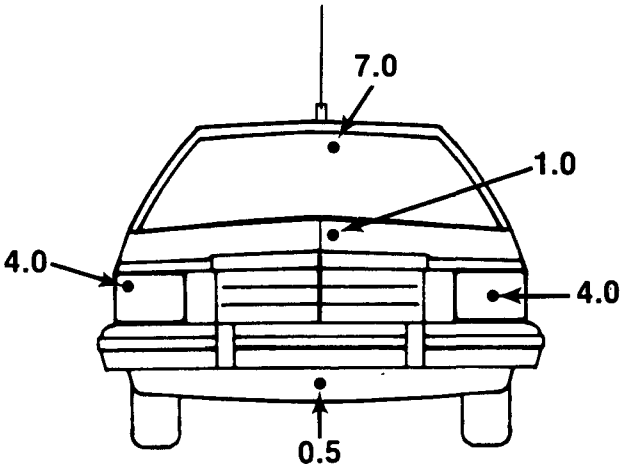


Figure 15. Maximum Energy Densities (nJ/m^3)
1973 Plymouth Fury 4 Door Sedan
Transmitter: 60 watts, 164.45 MHz



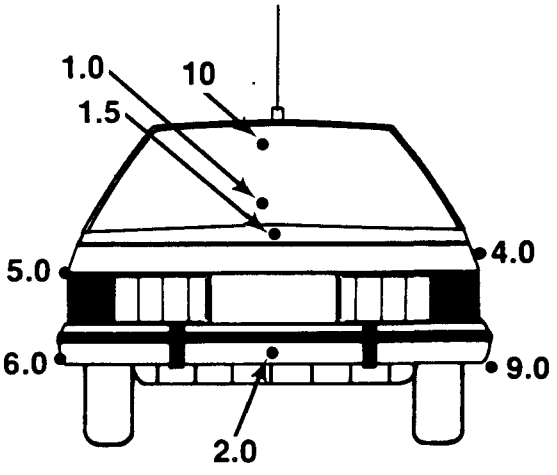


Figure 16. Typical Energy Densities (nJ/m^3)
1973 Plymouth Fury 4 Door Sedan
Transmitter: 60 watts, 164.45 MHz

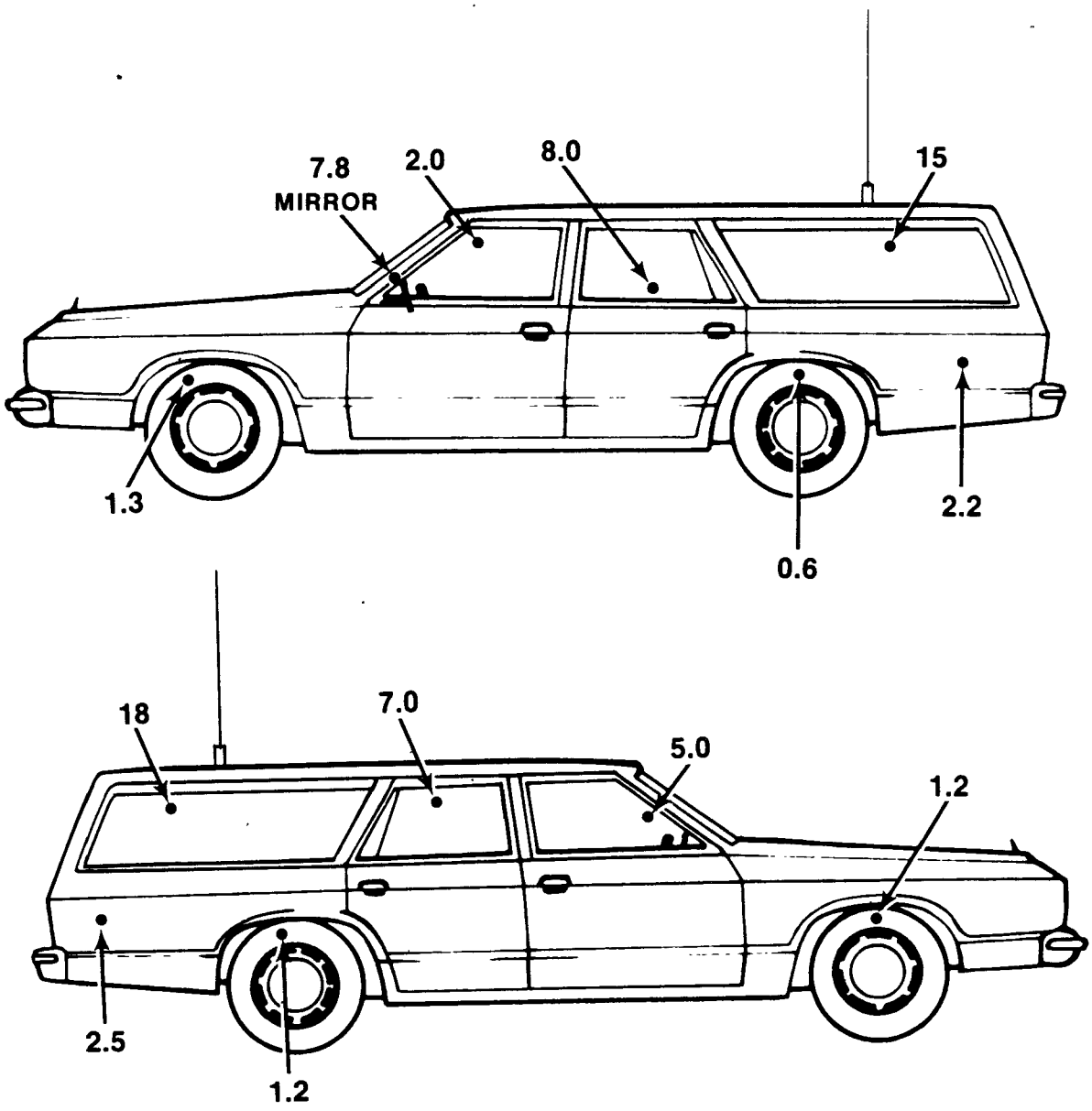
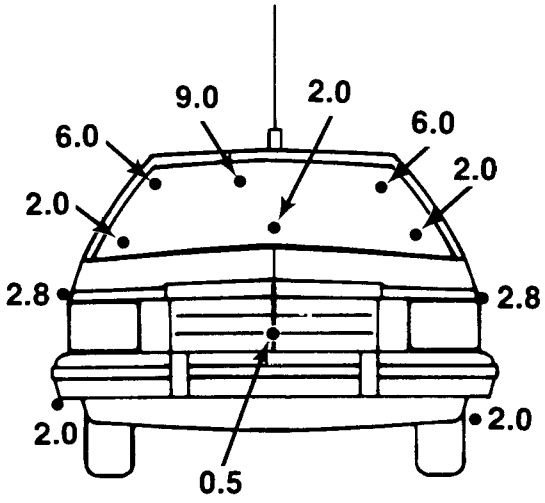


Figure 17. Maximum Energy Densities (nJ/m^3)
1974 Ford Torino Station Wagon
Transmitter: 60 watts, 164.45 MHz



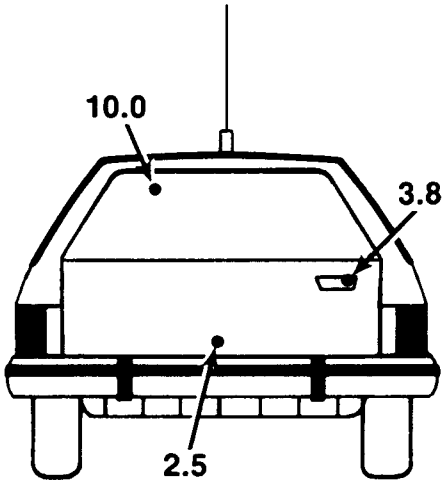


Figure 18. Typical Energy Densities (nJ/m^3)
1974 Ford Torino Station Wagon
Transmitter: 60 watts, 164.45 MHz

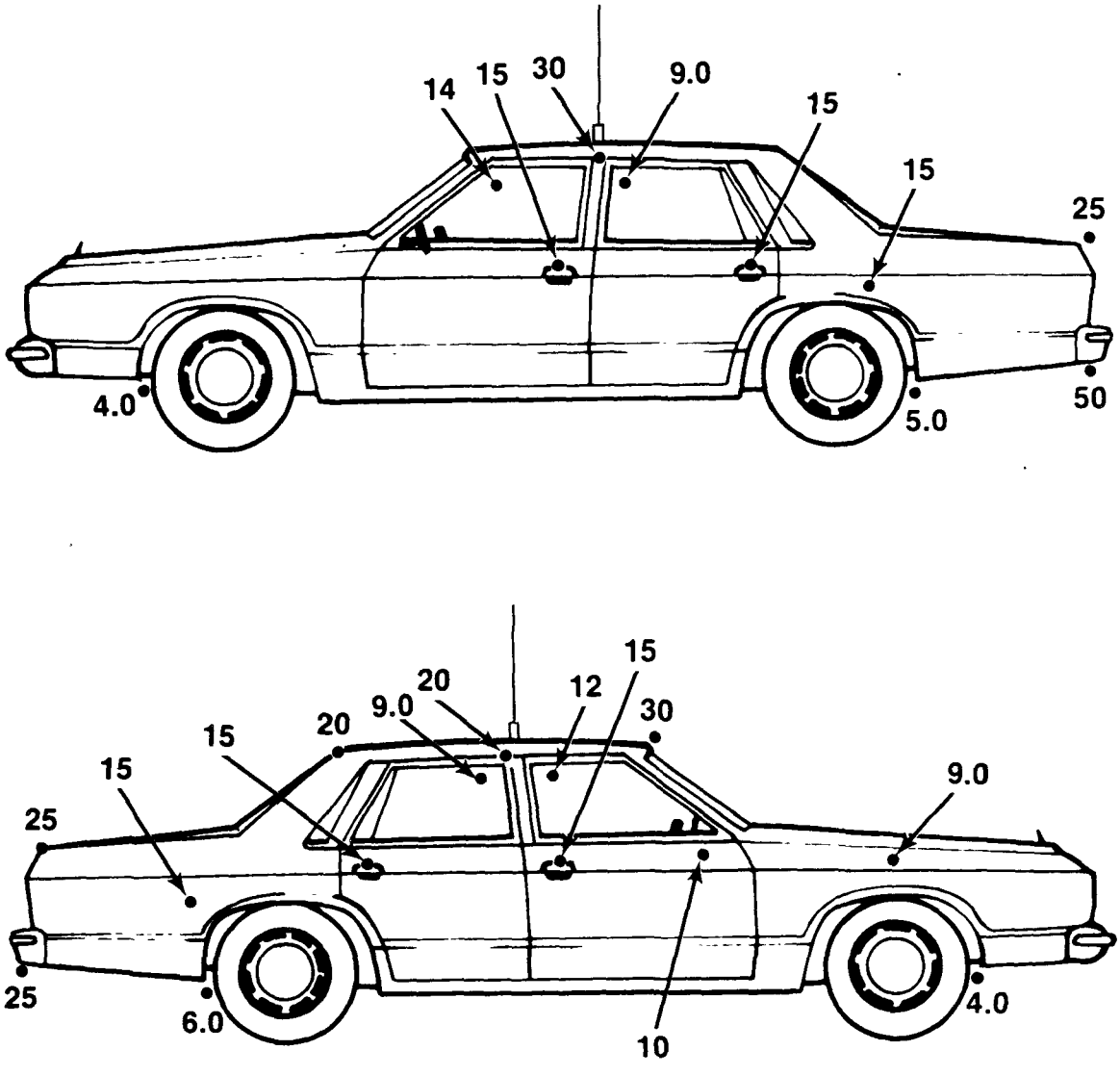
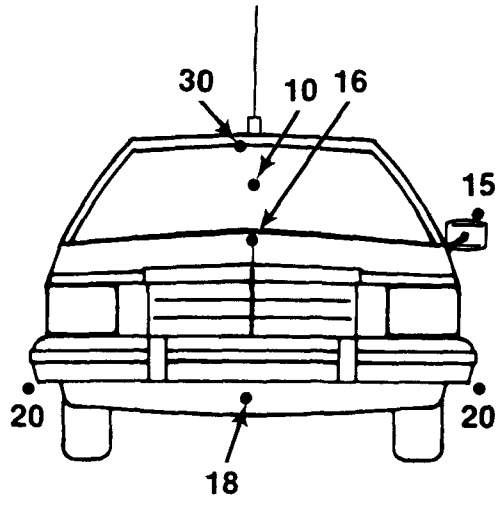


Figure 19. Typical Energy Densities (nJ/m^3)
1976 Ford Maverick 4-Door Sedan
Transmitter: 100 watts, 41.31 MHz



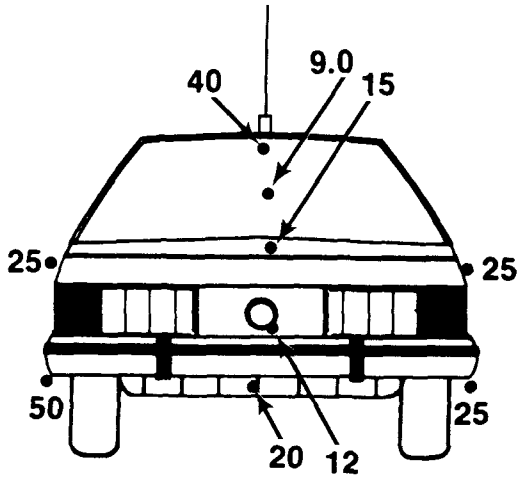


Figure 20. Typical Energy Densities (nJ/m^3)
1976 Ford Maverick 4-Door Sedan
Transmitter: 100 watts, 41.31 MHz

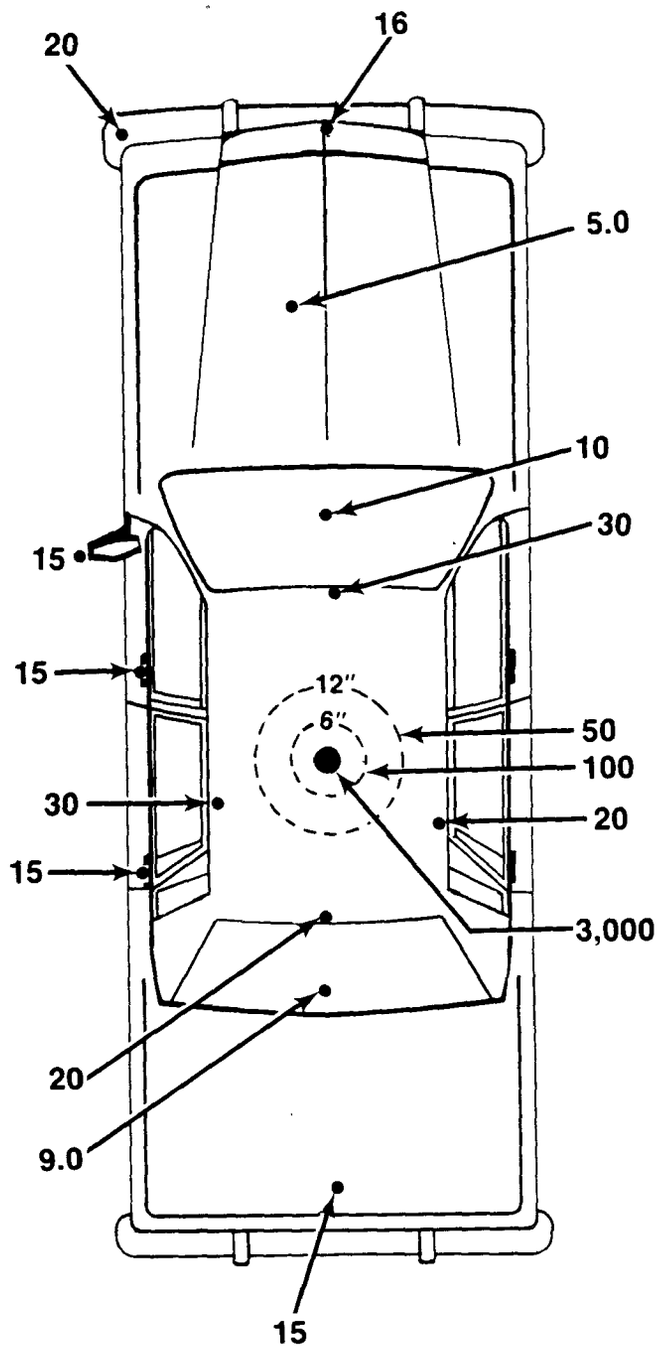


Figure 21. Typical Energy Densities (nJ/m^3)
1976 Ford Maverick 4-Door Sedan
Near antenna and other top areas

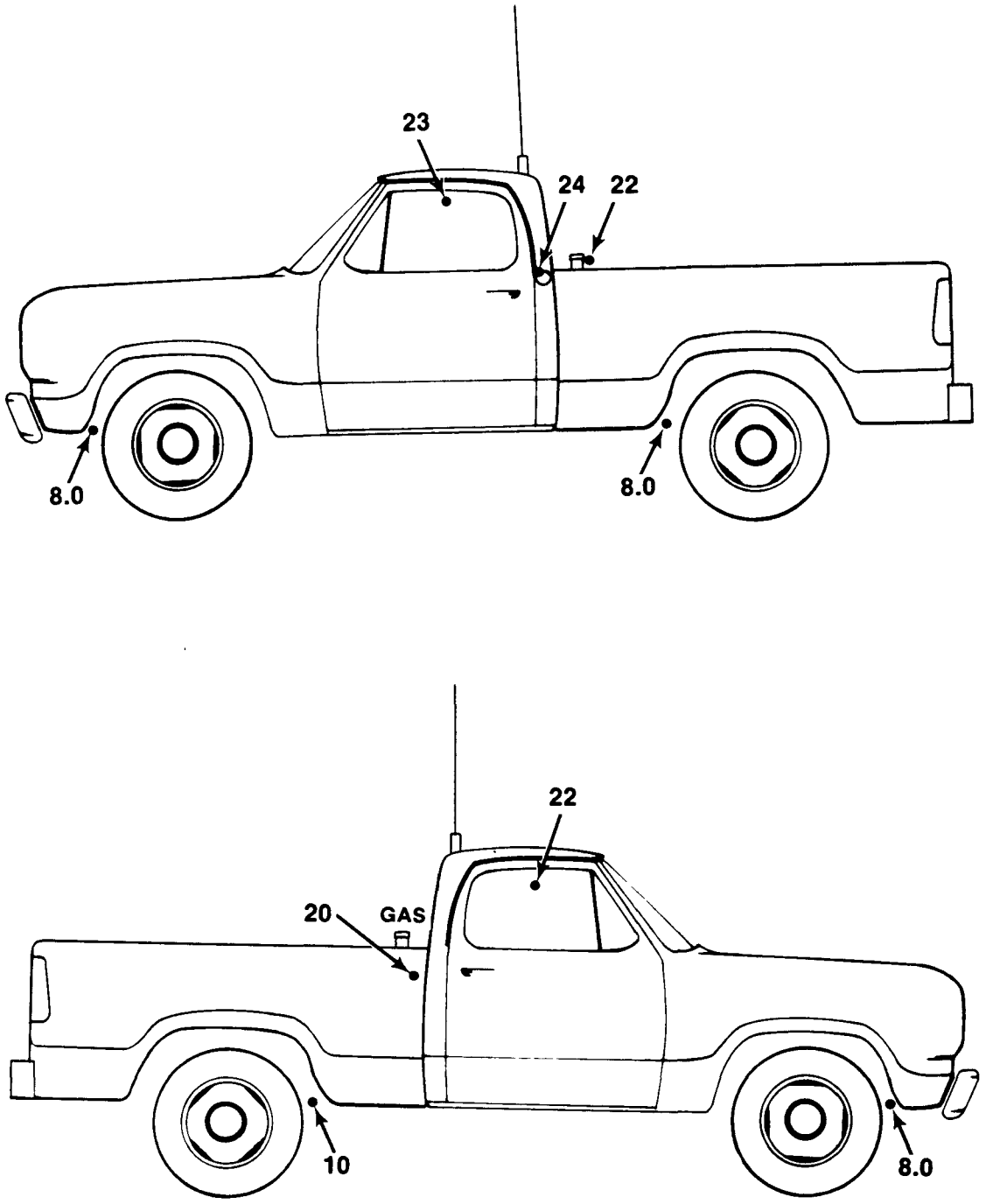


Figure 22. Maximum Energy Densities (nJ/m^3)
Truck #1 (1973 Dodge D200)
Transmitter: 100 watts, 41.31 MHz

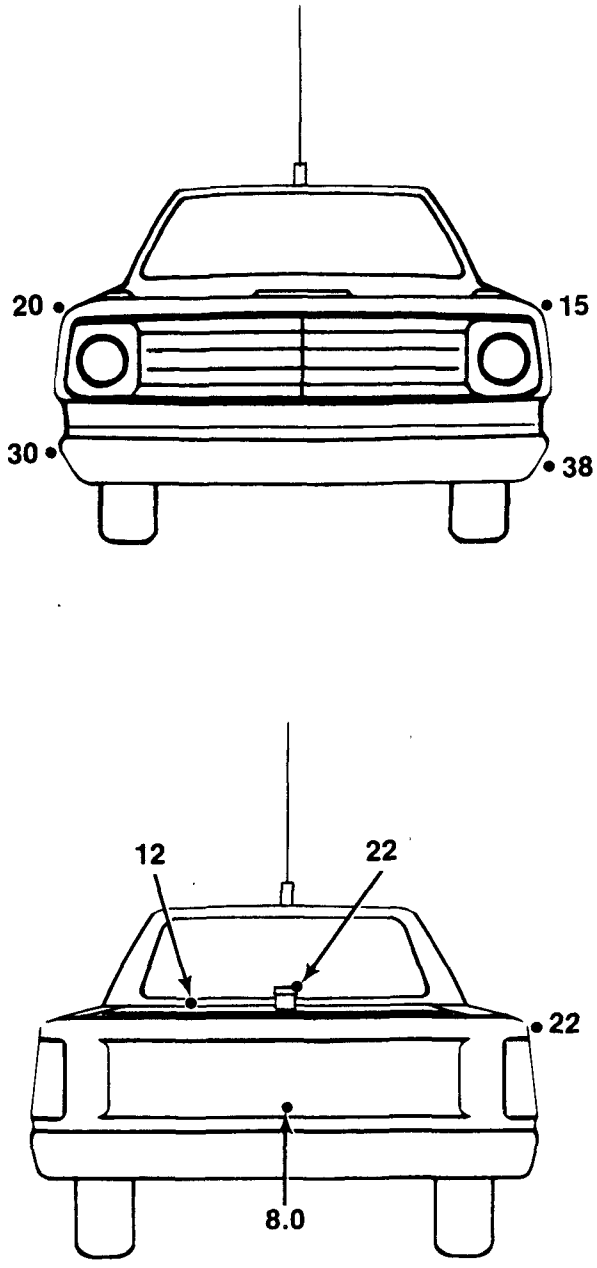


Figure 23. Maximum Energy Densities (nJ/m^3)
Truck #1 (1973 Dodge D200)
Transmitter: 100 watts, 41.31 MHz

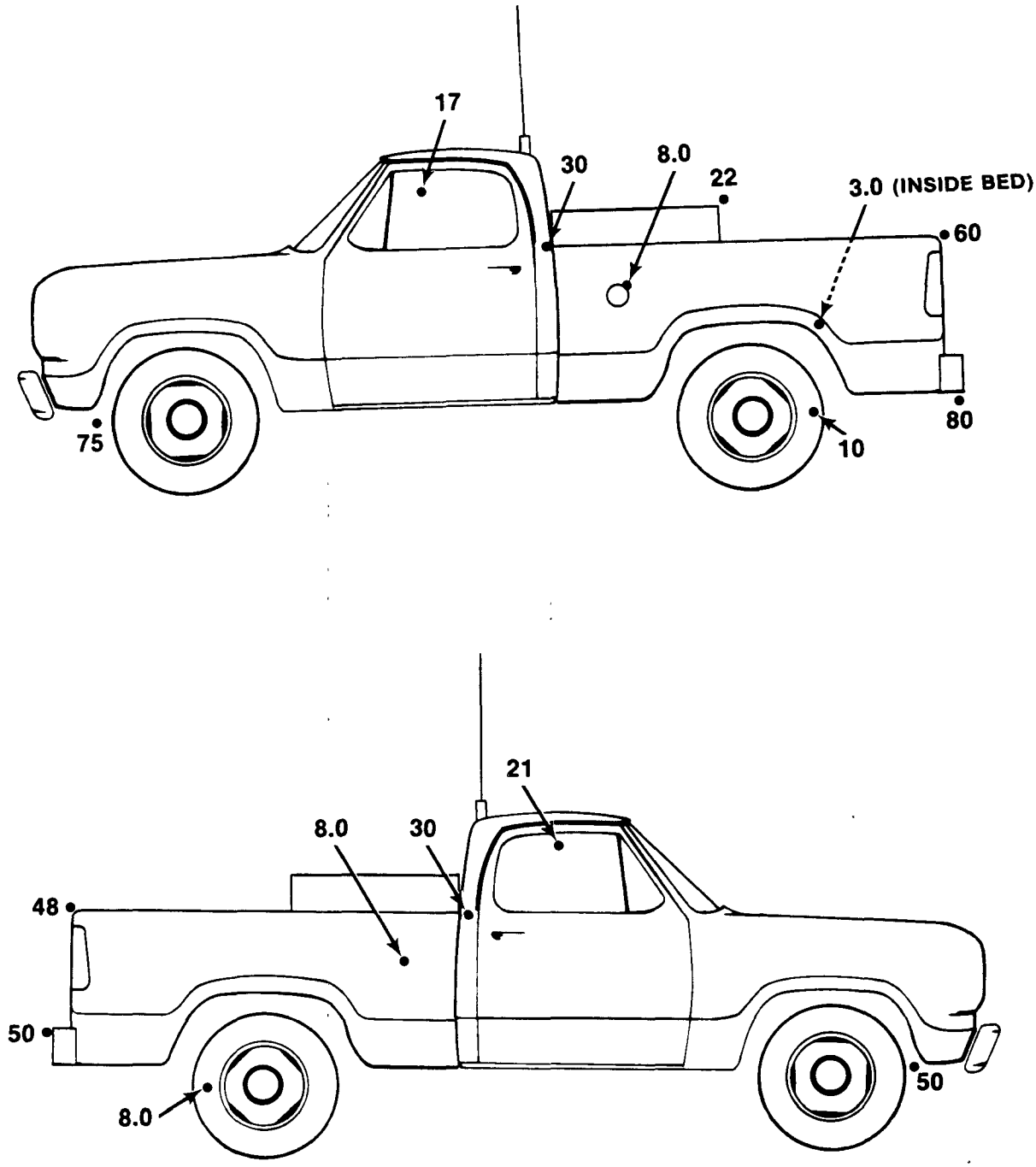


Figure 24. Maximum Energy Densities (nJ/m^3)
Truck #2 (1978 Dodge Power Wagon 150)
Transmitter: 100 watts, 41.31 MHz

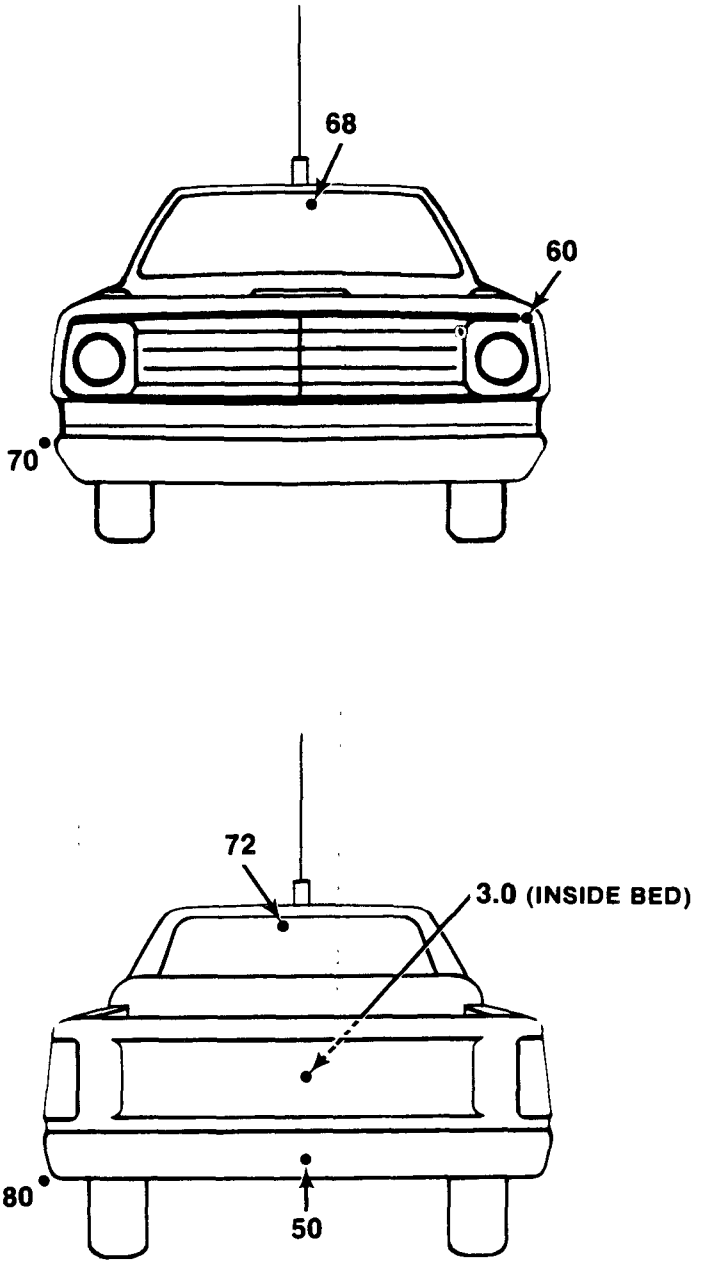


Figure 25. Maximum Energy Densities (nJ/m^3)
Truck #2 (1978 Dodge Power Wagon 150)
Transmitter: 100 watts, 41.31 MHz

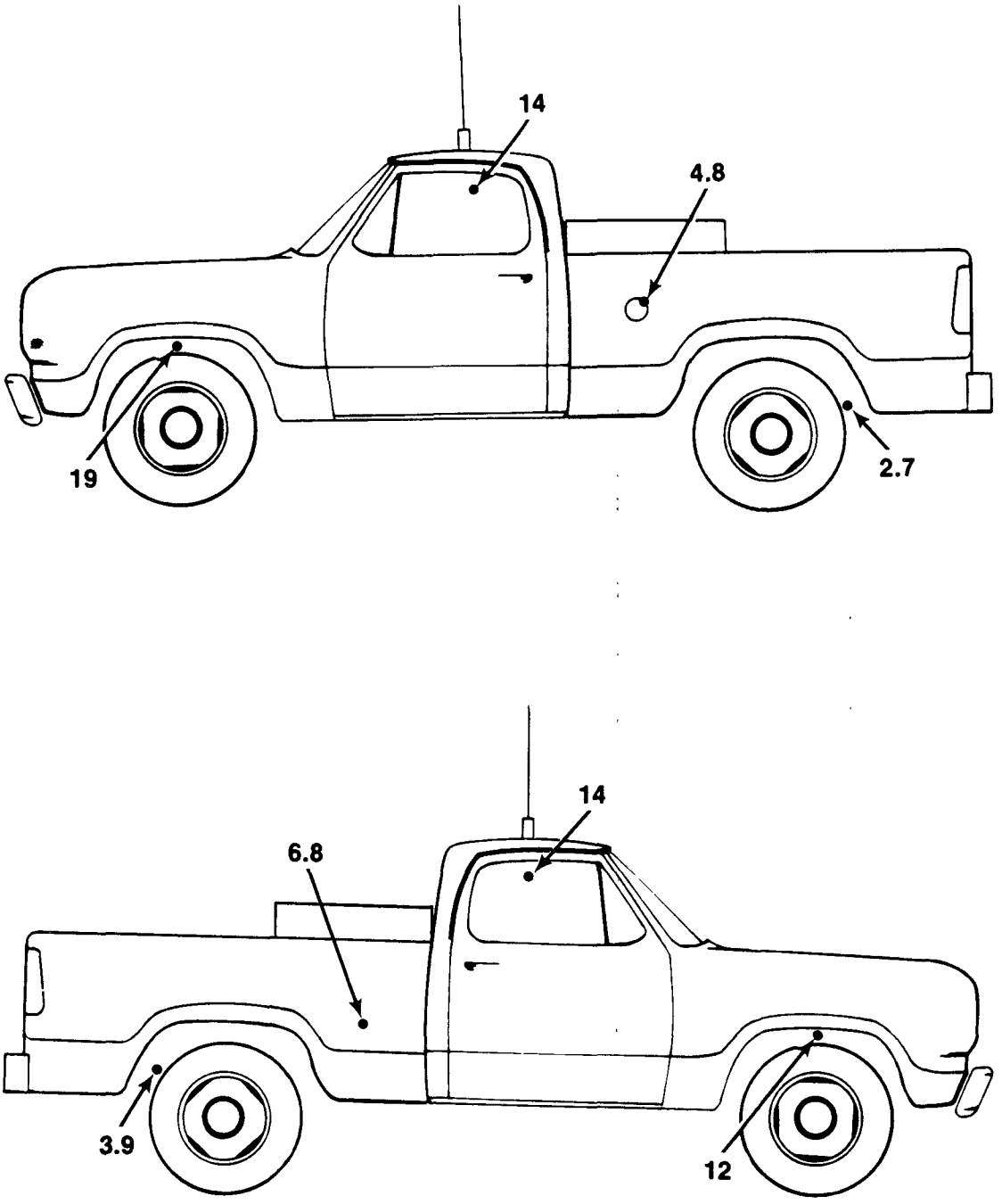


Figure 26. Maximum Energy Densities (nJ/m^3)
Truck #3 (1978 Dodge Power Wagon 150)
Transmitter: 100 watts, 41.31 MHz

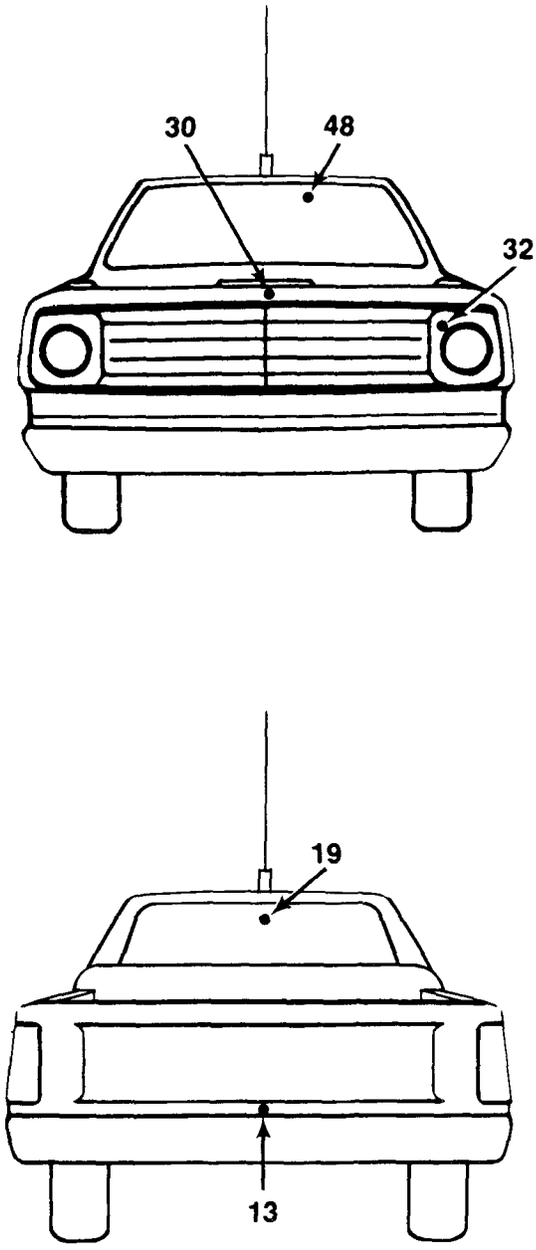


Figure 27. Maximum Energy Densities (nJ/m^3)
Truck #3 (1978 Dodge Power Wagon 150)
Transmitter: 100 watts, 41.31 MHz

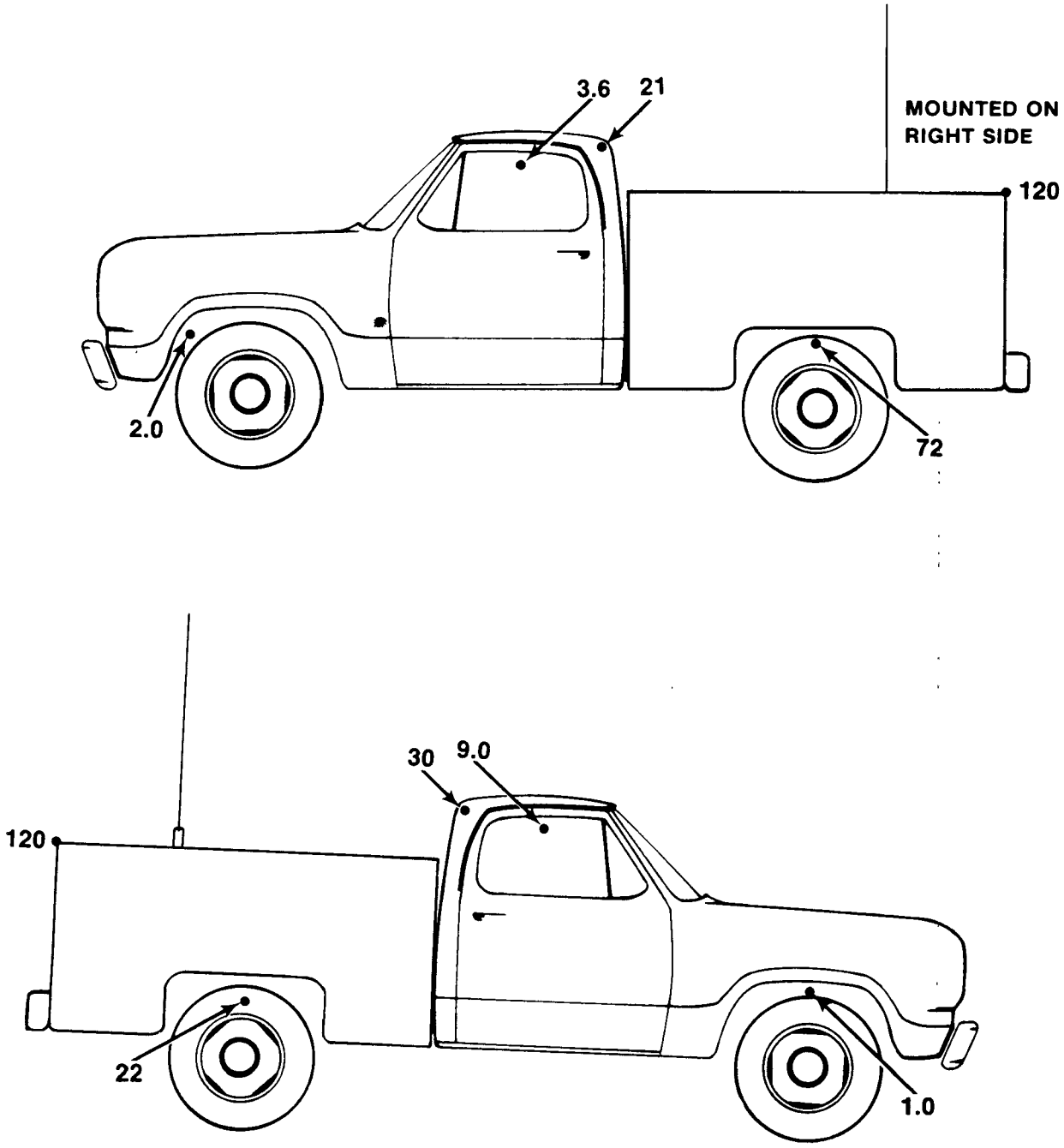


Figure 28. Maximum Energy Densities (nJ/m^3)
Truck #4 (1977 Chevrolet Custom Delux 20)
Transmitter: 100 watts, 41.31 MHz

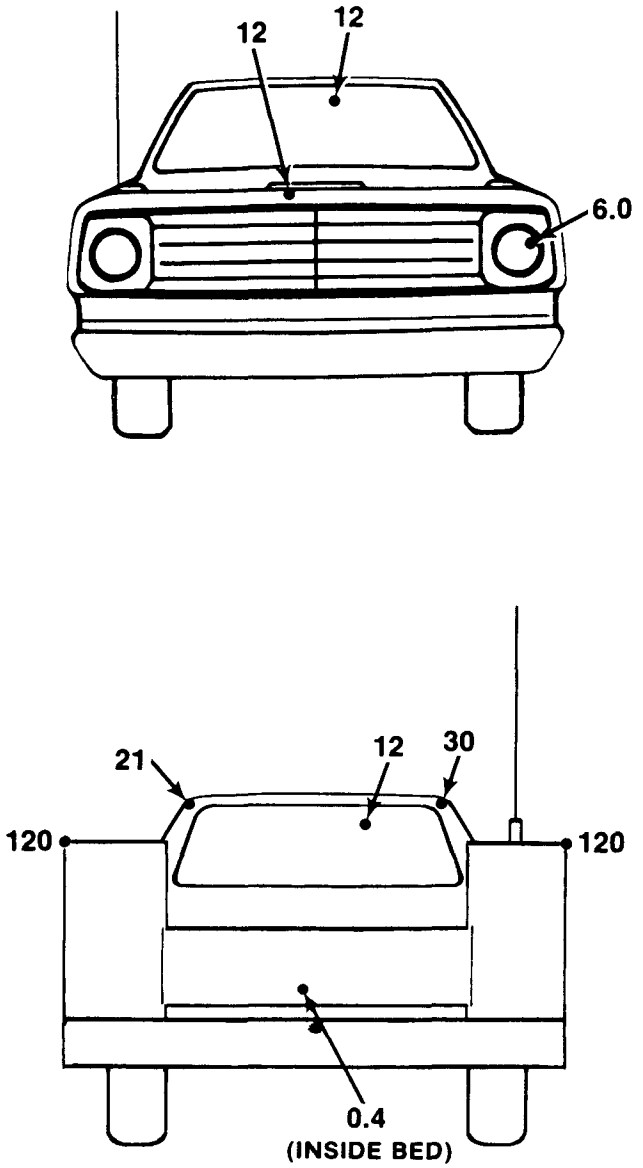


Figure 29. Maximum Energy Densities (nJ/m^3)
Truck #4 (1977 Chevrolet Custom Delux 20)
Transmitter: 100 watts, 41.31 MHz

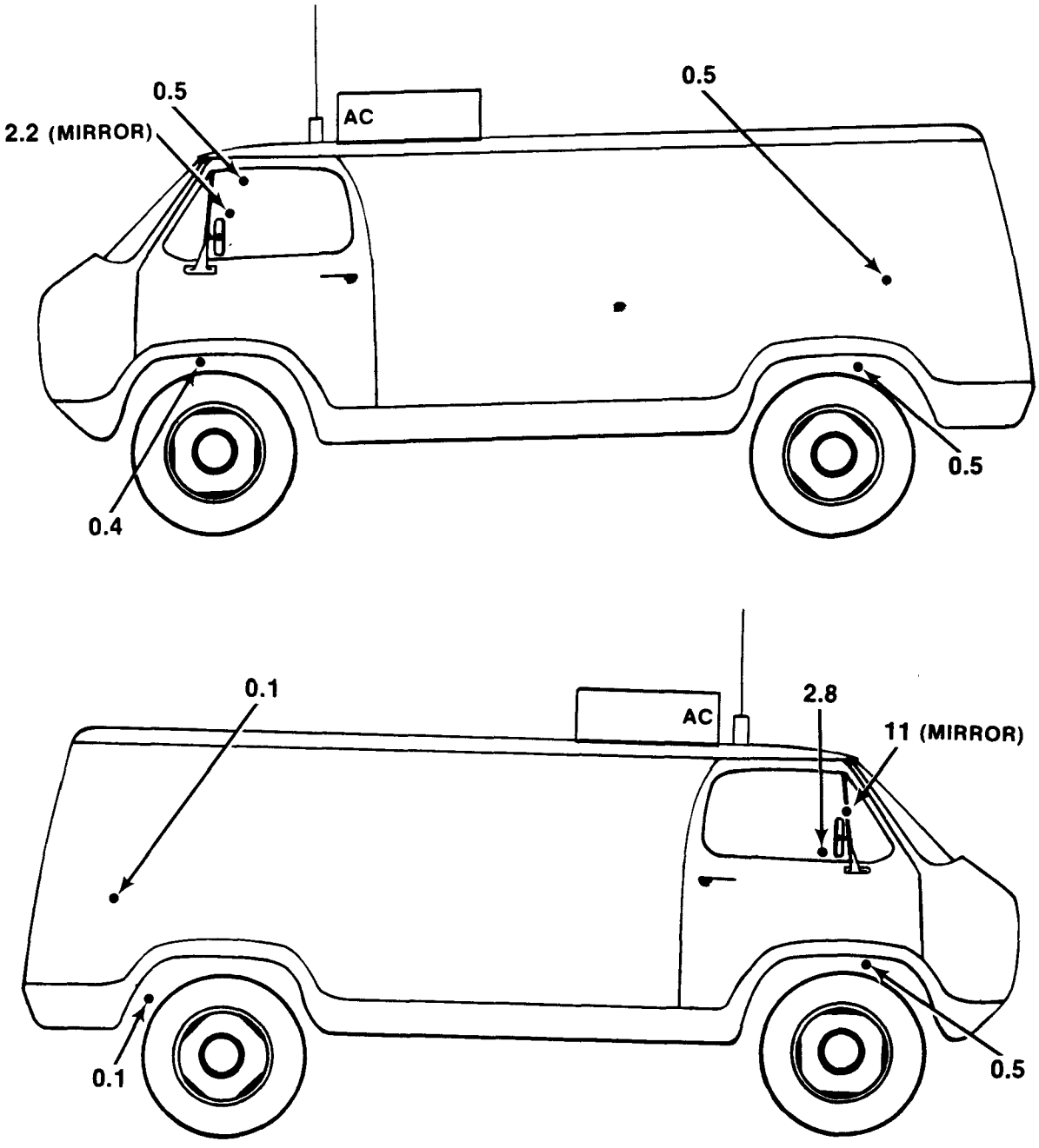


Figure 30. Maximum Energy Densities (nJ/m^3)
1973 Dodge Tradesman 300
Transmitter: 60 watts, 164.45 MHz

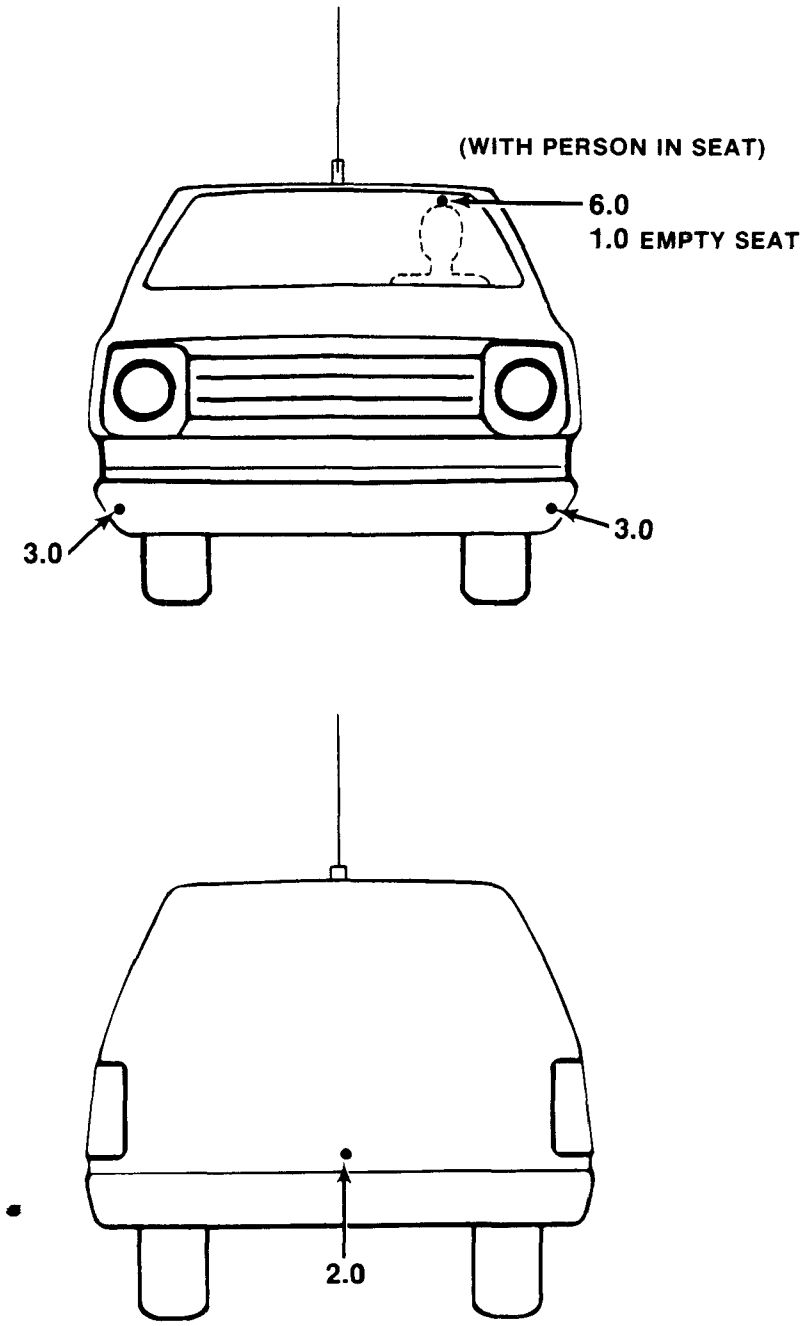


Figure 31. Maximum Energy Densities (nJ/m^3)
1973 Dodge Tradesman 300
Transmitter: 60 watts, 164.45 MHz

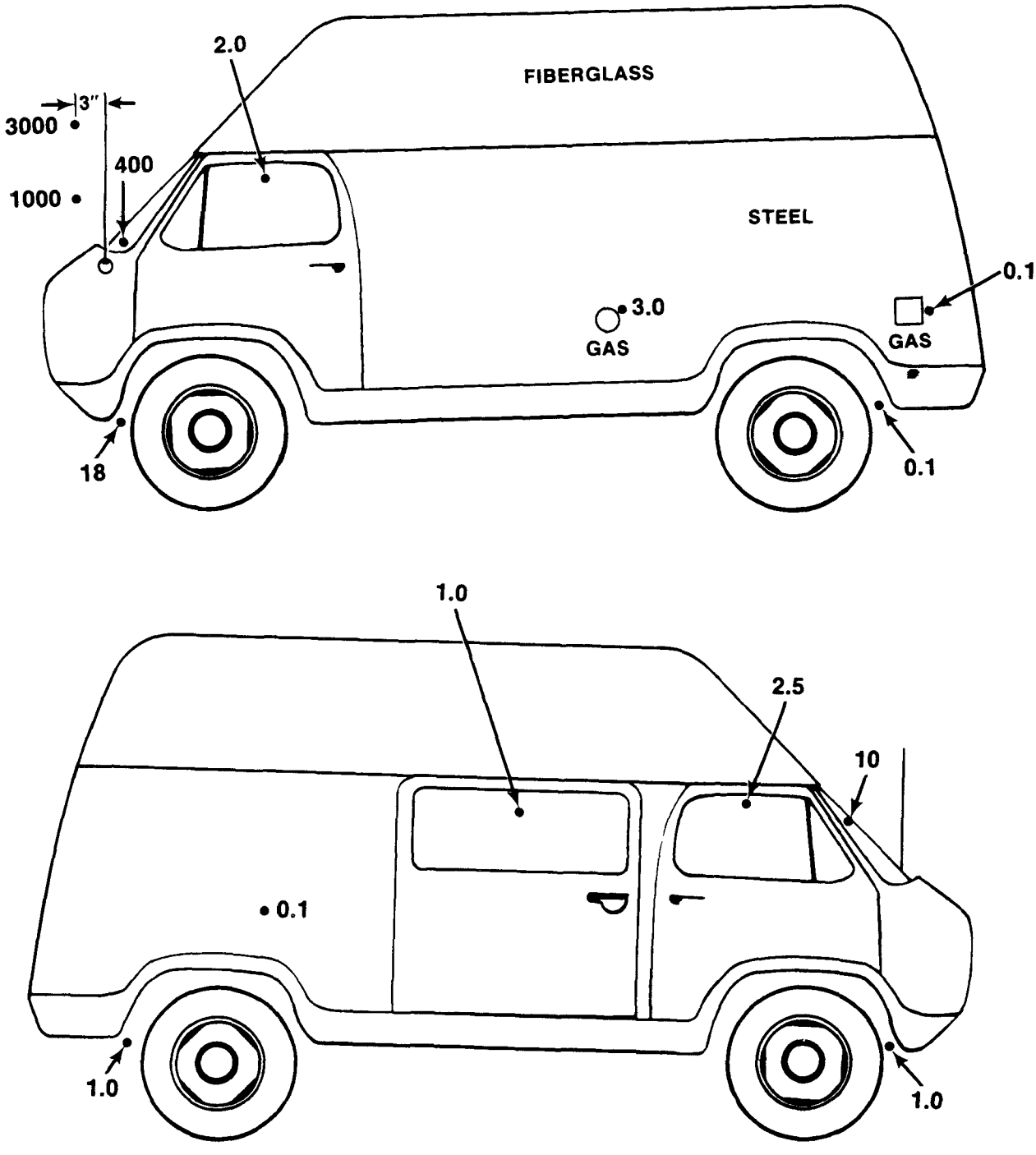


Figure 32. Maximum Energy Densities (nJ/m^3)
1971 Chevrolet Chevyvan 30 with Fiberglass Top
Transmitter: 60 watts, 164.45 MHz

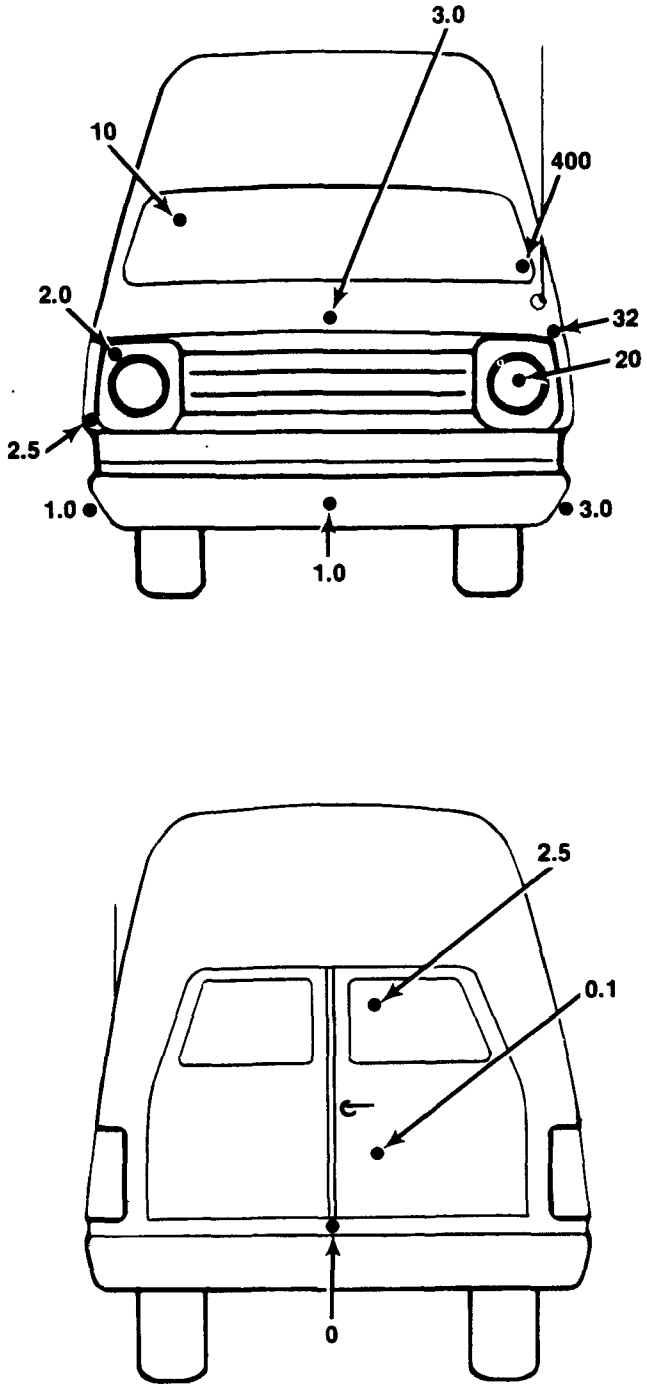


Figure 33. Energy Densities (nJ/m^3)
1971 Chevrolet Chevyvan 30 with Fiberglass Top
Transmitter: 60 watts, 164.45 MHz

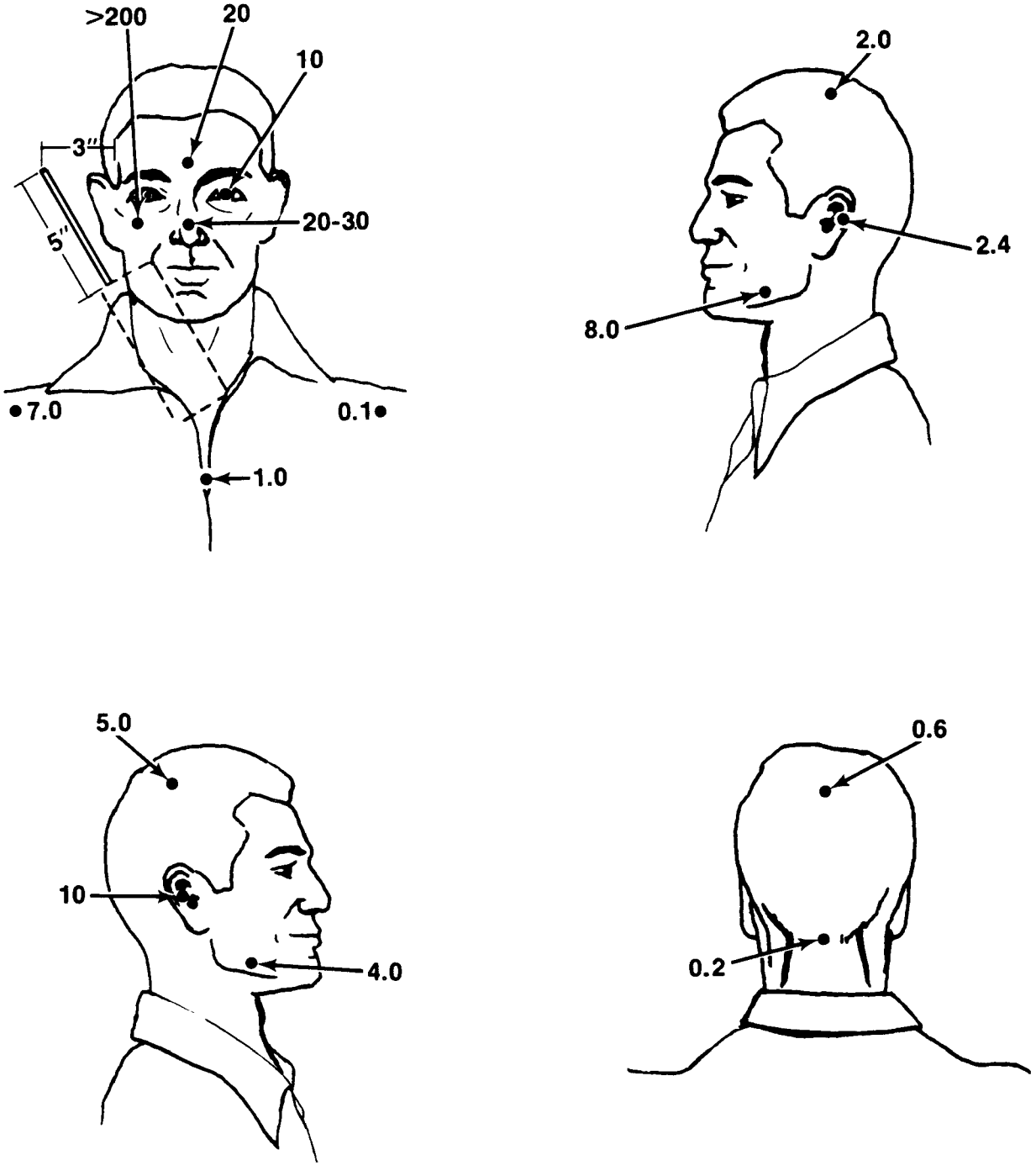


Figure 34. Energy Densities (nJ/m^3)
Head Area Exposure from a
Motorola HT-220 Walkie Talkie

APPENDIX

Vehicles with 60 watt/164.45 MHz transmitters

EPA Vehicle No.	Year	Make	Model	Type	Antenna/ Location
Vans					
21429	1973	Dodge	Tradesman 300	Van	ASP 446, roof mount
21316	1971	Chevrolet	Chevy van 30 with modified fiberglass top	Van	Phelps Dodge whip, front cowl mount
Sedans					
13887	1973	Plymouth	Fury 4 door	Sedan	ASP 446, roof mount
53169	1974	Ford	Torino	Station Wagon	ASP 446, roof mount

Vehicles with 100 watt/41.35 MHz transmitters

EPA Vehicle No.	Year	Make	Model	Type	Antenna/ Location
Pickup trucks					
#1 21622	1973	Dodge	D200	Pickup	ASP 446, roof mount
#2 80010	1978	Dodge	Power Wagon 150	Pickup	ASP 446, roof mount
#3 80008	1978	Dodge	Power Wagon 150	Pickup	ASP 446, roof mount
#4 70915	1977	Chevrolet	Custom Delux 20	Pickup	Phelps Dodge whip, rear fender mount
Sedan					
92182	1976	Ford	Maverick	4-door compact sedan	ASP 446, roof mount

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
ORP/EAD 79-2		

4. TITLE AND SUBTITLE	5. REPORT DATE
An Investigation of Energy Densities in the Vicinity of Vehicles with Mobile Communications Equipment and Near a Hand-Held Walkie Talkie	March 1979
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Donald L. Lambdin	
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Environmental Protection Agency Office of Radiation Programs Electromagnetic Radiation Analysis Branch P.O. Box 18416 Las Vegas, Nevada 89114	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency Office of Radiation Programs Electromagnetic Radiation Analysis Branch P.O. Box 18416 Las Vegas, Nevada 89114	13. TYPE OF REPORT AND PERIOD COVERED Technical Note
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

Exposure levels are examined in and around several types of vehicles equipped with mobile communications equipment. Additionally, exposure levels are observed near the head of an individual operating a hand-held walkie-talkie.

Measurements of energy densities inside vehicles indicate highest exposures occur near the head and near the driver's hands (when on the steering wheel). Outside the vehicles, highest exposure levels occur near sharp edges and corners, wheel wells, and certain protuberances. Exposure levels are greatly influenced by location of the antenna and degree of metallic shielding.

Highest exposure levels occur near the operator's eye for a hand-held walkie talkie.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Exposure levels associated with mobile communications equipment Energy density measurement Exposure levels near hand-held walkie-talkies		

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release to public	Unclassified	62
	20. SECURITY CLASS *(This page)*	22. PRICE
	Unclassified	

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